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# iQ-ANALYZER

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User Manual

6.2.4

June, 2020



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# 1 INTRODUCTION

The iQ-Analyzer is an executable program for Windows and MAC. It analyzes digital images and video frames using specified test charts. Using the full version of the iQ-Analyzer you will get information about all important characteristics of a digital camera system including

- OECF
- Dynamic Range
- White Balancing
- Noise and ISO-Speed
- Visual Noise
- MTF
- Limiting resolution
- Distortion / lateral and longitudinal chromatic aberration
- Vignetting / Shading
- Flare
- Color reproduction

For more information about iQ-Analyzer and the supported test charts please visit our website [www.image-engineering.de](http://www.image-engineering.de).



## 2 INSTALLING iQ-ANALYZER

### 2.1. SYSTEM REQUIREMENTS

	Windows (32bit and 64bit)	Mac (64bit only)
Operating Systems	Windows 7 Windows 8 Windows 8.1 Windows 10	Mac OS X 10.13 up to 10.15
Processors	Any Intel or AMD x86 processor supporting SSE2 instruction set**	All Intel-based Macs with an Intel Core 2 or later
RAM	2048 MB (4096 MB recommended)	2048 MB (4096 MB recommended)
Additional Hardware (for Video Module only)	DeckLink, Multibridge or Intensity products by Blackmagic Design Video input hardware supported by MATLAB***	Not supported

\*\* SSE2 was introduced into Intel chips with the Pentium 4 in 2001 and AMD processors in 2003. Most computers produced in the last several years are equipped with SSE2. All Intel Macs are equipped with SSE2. If you are unsure about your particular Windows PC, you can determine SSE2 support by a free tool, ProcFeatures. It is available from Microsoft SysInternals that will indicate if SSE2 is present on your system or not (<http://technet.microsoft.com/en-us/sysinternals/bb897554.aspx>).

\*\*\* In order to use the Video Module for live measurements (not for video files), an appropriate video input hardware is needed. If you do not use a DeckLink, Multibridge or Intensity product by Blackmagic Design, please refer to the list of the hardware supported by MATLAB's Image Acquisition Toolbox (<http://www.mathworks.de/products/imaq/supportedio.html>).

### 2.2. SOFTWARE PROTECTION

iQ-Analyzer is protected with an USB dongle. You have to connect the dongle to your system every time you use iQ-Analyzer. If you don't have a dongle, please contact [sales@image-engineering.de](mailto:sales@image-engineering.de)

### 2.3. INSTALLATION

1. Download and install MATLAB Compiler Runtime (MCR) Version 9.3. You will find it on the provided USB-Stick or you can download it [here](#).



If you experience any problems, please contact [support@image-engineering.de](mailto:support@image-engineering.de)

Note: The iQ-Analyzer V6.2.4 needs the MCR version 9.3. Earlier versions of the iQ-Analyzer use other MCRs.

Note (for Mac OS X only): Installing multiple versions of the MCR on the same machine is not supported on Mac OS X. When you install a new MCR onto a target machine, you must delete the old version of the MCR and install the new one. You can only have one version of the MCR on the target machine. To remove the MCR, simply move the MCR folder from /Applications to the trash. The MCR is installed in /Applications/MATLAB Compiler Runtime/Vxx, where 'xx' is the version of the installed MCR.

2. Download the latest version of the iQ-Analyzer from our server (<http://www.image-engineering.de/downloads/software>)
3. Start the installation by running the installer and follow the instructions. You can store the software to any folder on your system (on Mac OS X it must be the local „Applications“ folder).

Note (for Mac OS X only): The software will not start if it is not in the local „Applications“ folder. If you want to use it from another location:

- Open Automator
  - Drag and drop the iQ-Analyzer.app onto the Automator Icon
  - Modify the path in the script
4. Install additional open source software.
    - a) Mac users have to manually install ExifTool by Phil Harvey. The installation file is located in the „3rdParty“ folder of the iQ-Analyzer. Also ghostscript should be installed on the Mac to export PDF reports. This needs to be installed separately. PC users can omit this step.
    - b) In order to analyze video files using the Video Module, PC users have to manually install the VLC Media Player. It is necessary to make sure that the ActiveX Plugin option is selected during the installation. The Video Module is currently not supported on Macs.

## 2.4. ANTIVIRUS ISSUES

Some few anti-virus products may detect a virus in „iqa6.exe“ in the iQ-Analyzer folder. This is a false alarm, some code blocks are accidentally detected as a virus. Please contact our support ([support@image-engineering.de](mailto:support@image-engineering.de)) if you experience this problem.

Note(for Mac OS X only): Umlauts and other special characters are not supported on Mac OS X.



## 2.5. SOFTWARE BY THIRD PARTIES

iQ-Analyzer uses open source software

.....  
FFmpeg

Copyright © 2000-2010 by the FFmpeg developers

iQ-Analyzer is distributed with an automated FFmpeg 32-bit Windows build made by Ramiro Polla.

FFmpeg is licensed under GNU LGPL and GNU GPL licenses.

FFmpeg is linked with libX264 (GPL).

You can download the complete source code used to build FFmpeg here:

<http://ffmpeg.arrozcru.org/autobuilds/>

.....  
VLC

Copyright © 1996-2010 by the VideoLAN-Team

iQ-Analyzer is distributed with a Windows installer of VLC Player. Please make sure the ActiveX plugin is installed in order to use the Video Module with video files.

VLC media player is licensed under GNU GPL (<http://www.gnu.org/licenses/gpl.txt>)

You can download the complete source code here:

<http://www.videolan.org/vlc/download-sources.html>

.....  
ExifTool

Copyright © 2003-2010 by Phil Harvey

iQ-Analyzer is distributed with the stand-alone Windows executable of ExifTool. This is free software.

To install ExifTool on Mac OS X please follow the instructions on the ExifTool homepage (<http://www.sno.phy.queensu.ca/~phil/exiftool/>)

You can download the complete source code here: <http://www.sno.phy.queensu.ca/~phil/exiftool/>

.....  
dcraw

Copyright © 1997-2010 by Dave Coffin

iQ-Analyzer is distributed with custom builds of dcraw for Windows and Mac OS X. This is free software.

You can download the complete source code here: <http://www.cybercom.net/~dcoffin/dcraw/>

.....  
Ghostscript

Copyright © 2014 Artifex Software, Inc



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iQ-Analyzer is distributed with a Windows stand-alone executable of Ghostscript for Windows. This is free software. Ghostscript is licensed under GNU Affero GPL license

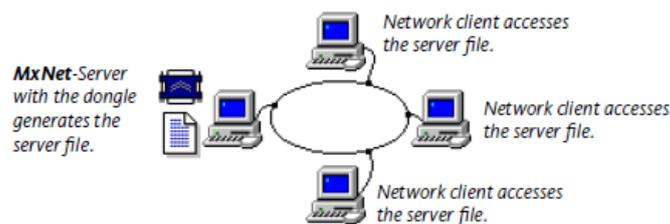
You can download the complete source code here: <http://www.ghostscript.com>



## 2.6. NETWORK SITE LICENSE (for WINDOWS only)

### 2.6.1. Overview

The network site license allows you to use iQ-Analyzer on a defined number of computers in a network using only one dongle. The management of the simultaneously running versions of iQ-Analyzer is performed with the help of user slots in a server file, generated by the MxNet server program by "TechnoData Interware GmbH".



MxNet functional principle is shown in the diagram above. The server program running on a computer with the dongle generates an encoded server file. Each running version of the iQ-Analyzer "connects" with the server file and occupies a user slot, that is being released when the application is closed. The network protection via MxNet does not use network protocols and can thus be used in any network system.

### 2.6.2. Installation of MxNet

Copy `mxnet32.exe` from the `\3rdParty\MxNet\` in the iQ-Analyzer installation folder to the `C:\Windows\system\` directory on the computer that will act as the MxNet server.

Connect the dongle to this computer and run `mxnet32.exe`. The MATRIX-NET program is the MxNet server application and must run on the MxNet server PC (computer with the dongle). This application generates and refreshes the MxNet server file.

The MxNet server program can also be registered as a Windows service, so that the program is started automatically during the boot-up of Windows. The advantage of a service over an Autostart entry is that the service is also started if there is no User-Login in Windows. You can directly register MxNet as a service by starting MxNet with the corresponding parameters. The following call-up parameters are available:

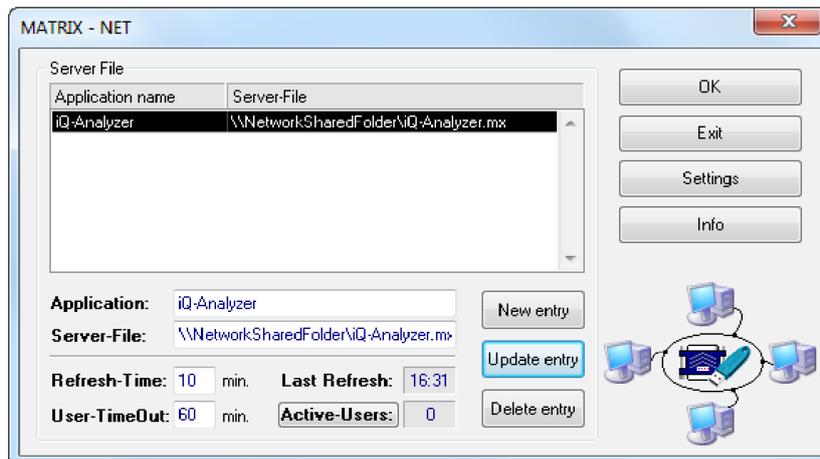
`mxnet32.exe -i` (Install MxNET service)

`mxnet32.exe -r` (Uninstall MxNET service)



### 2.6.3. Matrix-Net

After starting the Matrix-Net program, a dongle symbol is displayed in the task bar. Clicking on this icon will activate the Matrix-Net dialog.



Enter a name for the program in the field "Application name" of the MxNet program (e.g. iQ-Analyzer). The name can be anything you like and it does not need to match the actual application name. The network licenses will be managed using the server file \\NetworkSharedFolder\\iQ-Analyzer.mx in this example. The name of the server file must always be entered with the absolute path and correspond to the naming conventions of the operating system.

#### REFRESH-TIME

In this field, the time interval for the refresh of the server file is set. The last refresh carried out is displayed in the "Last Refresh" field. The refresh period should usually be selected to be between 5 and 10 minutes.

#### USER-TIMEOUT

The User-TimeOut is the time limit after which the user is automatically removed from the server file. In the case of abnormal termination of the application (crash) on a client, this function ensures the release of the user slot in the server file, as this would otherwise remain occupied.

#### ACTIVE-USERS

This field is continuously updated and shows the total number of active users for the selected application. The "Active-Users" button allows you to display a detailed list of the active users. A user entry can be manually removed from this list.

If your application is terminated abnormally on any terminal, you can either remove the user slot from the list or wait for the time out. When the user time out is reached, the user slot is automatically removed



the next time the server file is refreshed. It is not necessary to delete the user slot before the abnormally terminated application is restarted. The existing user slot will be found and refreshed automatically.

**Important!**

**It is very important that the system time of the PC is synchronized in the network. Otherwise the “User-TimeOut” can not be correctly computed. The maximum allowed deviation of the system time between clients and server, may not exceed the number of minutes, which was selected in the MxNet server program in “Refresh-Time”. The following command can be used to synchronize the system time of the clients with the system time of the server. This command can be implemented in the boot-up procedure of each client to make it an automatic function.**

```
NET TIME \\<computername> /SET /YES
```

#### **2.6.4. iQ-Analyzer**

After installing and running MxNet server, install iQ-Analyzer on every computer where it should be used. On each computer open the file pathToMxNetFile.txt in the program folder of the iQ-Analyzer directory and put the full path to the server file into the first line (in the example above it was \\NetworkSharedFolder\iQ-Analyzer.mx). Save this file and start iQ-Analyzer.

**Important!**

**Make sure that the server file is accessible from each computer.**



### 3 COMMAND LINE INTERFACE for CMD

iQ-Analyzer provides a command line interface allowing you to analyze image quality by issuing text commands. This interface is particularly suitable for automating tasks using scripting.

#### 3.1. SYNTAX

In order to use the command line interface of iQ-Analyzer please run the file iqa6cmd.exe in the Windows command prompt. Running this file without parameters or with the parameter help will give you an overview of the command syntax.

After a successful analysis the results, as well as other output files, such as check images, will be written according to the settings used.

```
C:\Windows\system32\cmd.exe

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iqa6cmd.exe help
Warning: application is running on a locale different from the original platform
locale.

----- iQ-Analyzer CMD -----

Syntax:
iqa6cmd <Input> <SettingFile> <Module> <Options>

<Input> Can be one of the following:
- Path to the image file (e.g. C:\temp\image_01.jpg)
- Path with wildcart for multiple files (e.g. C:\temp\image_*.jpg)
- "input" for initalizing the MCR and keeping iQ-Analyzer running
- "input" for analyzing files listed in a .txt (see manual)
- "observe" for controlling iQ-Analyzer with a .txt file

<SettingFile> Can be one of the following:
- Path to the .txt file (e.g. C:\temp\iQ-AnalyzerSettings.txt)
- Path to the .myset file (e.g. C:\temp\TE268_default.myset)
- ONLY MODULE 42: path to the .42 file (e.g. C:\temp\TE42_default.42)

<Module> Can be one of the following:
- oecf
- resolution
- shading
- distortion
- 42
- color

<Options> Use options to overwrite current .myset settings (see manual)

-----

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>_
```



General syntax:

**iq6cmd.exe <Input> <SettingFile> <Module> <Options>**

**<Input>** Can be one of the following:

- Path to the image file (e.g. C:\temp\image\_01.jpg)
- Path with wildcard for multiple files (e.g. C:\temp\image\_\*.jpg)
- "input" for initializing the MCR and keeping iQ-Analyzer running
- "input" for analyzing files listed in a .txt
- "observe" for controlling iQ-Analyzer with a .txt file

**<SettingFile>** Can be one of the following:

- Path to the .txt file (e.g. C:\temp\iQ-AnalyzerSettings.txt)
- Path to the .myset file (e.g. C:\temp\TE268\_default.myset)
- ONLY MODULE 42: path to the .42 file (e.g. C:\temp\TE42\_default.42)

**<Module>** Can be one of the following:

- oecf
- resolution
- shading
- distortion
- 42
- color

**<Options>** Use options to overwrite current .myset settings



## 3.2. EXAMPLES

### Example 1 – Analyzing a single image file using default settings

Please note that the .myset files are located in the subfolder “Setting” in the program directory by default. You can save and load your own .myset files using the graphical user interface of iQ-Analyzer.

Syntax:

```
iqa6cmd.exe <ImageFile> <MysetFile> <Module>
```

Example:

```
iqa6cmd.exe "C:\temp\samples\set1\TE188_1.jpg" "C:\Program Files (x86)\Image  
Engineering\iQ-Analyzer V6.1.016\Setting\TE188_default.myset" color
```



Result:

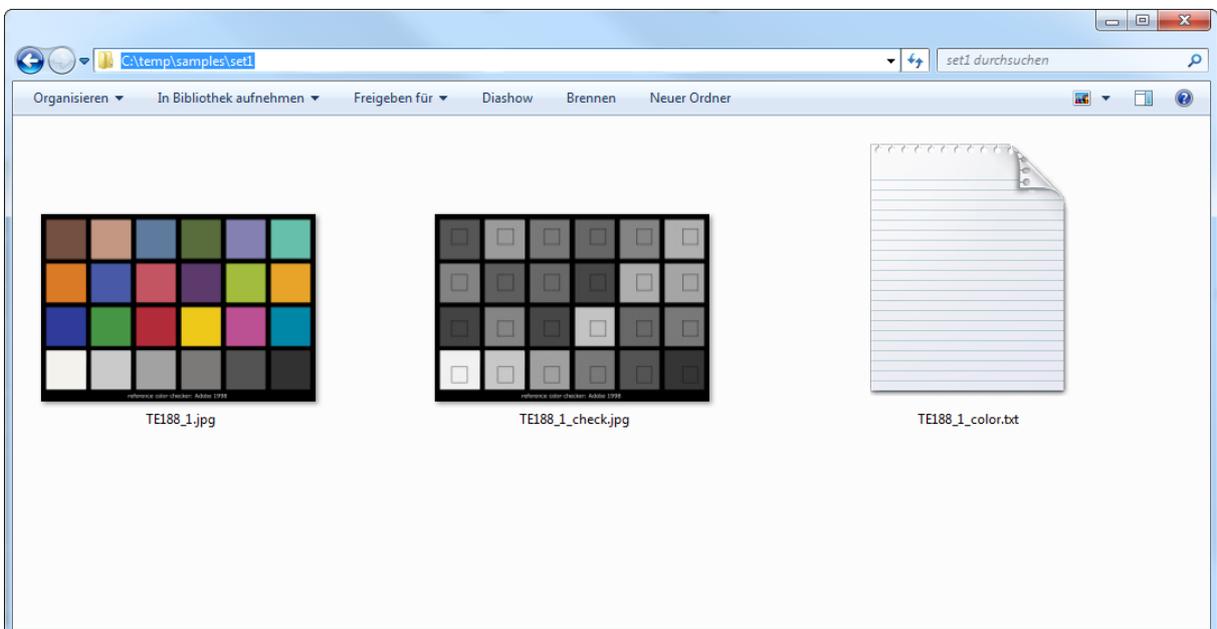
```
C:\Windows\system32\cmd.exe

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iqa6cmd.exe "C:\temp\samples\set1\TE188_1.jpg" "C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Setting\TE188_default.myset" color
Warning: application is running on a locale different from the original platform locale.

iQ-Analyzer Command Line Version: 6.1.016

Start
Locate Chart(s)      .
Locate ROIs         .
Correct ROIs        .
Analyze             .
Calculate Results   .
Write Results       .
Done

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```





## Example 2 – Analyzing a single TE42 image file using default settings (Module 42)

Instead of using the path to a .myset file as described in the previous example, you must pass the path to a .42 file as the second input parameter. The third parameter **<Module>** must be set to 42.

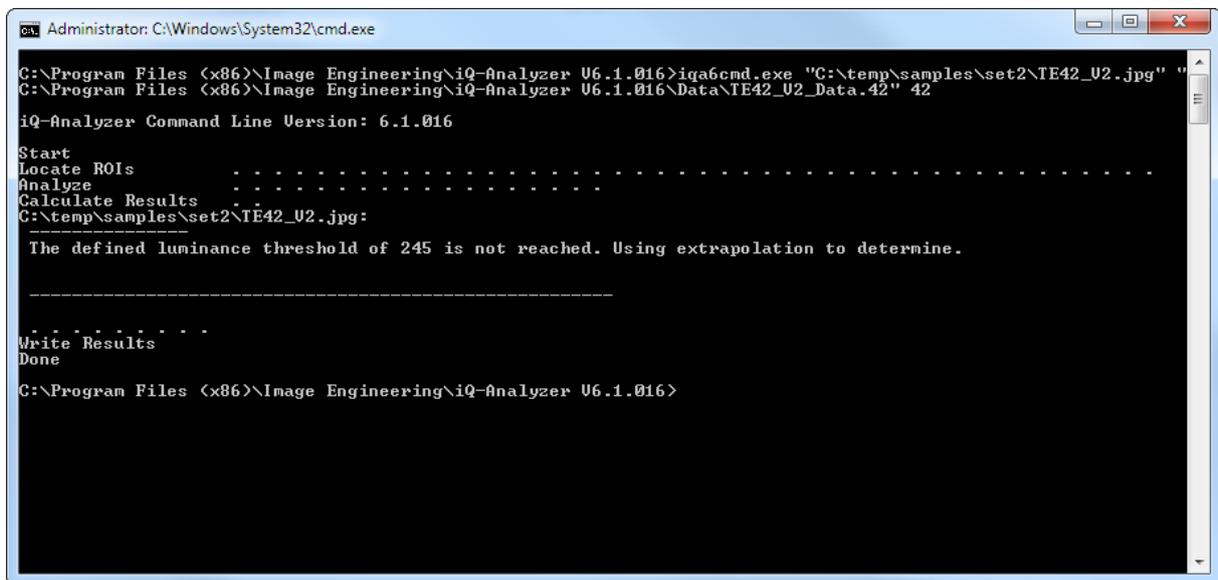
Syntax:

***iga6cmd.exe <ImageFile> <42-File> 42***

Example:

***iga6cmd.exe "C:\temp\samples\set2\TE42\_V2.jpg" "C:\Program Files (x86)\Image Engineering\iQ-Analyzer V6.1.016\Data\TE42\_V2\_Data.42" 42***

Result:



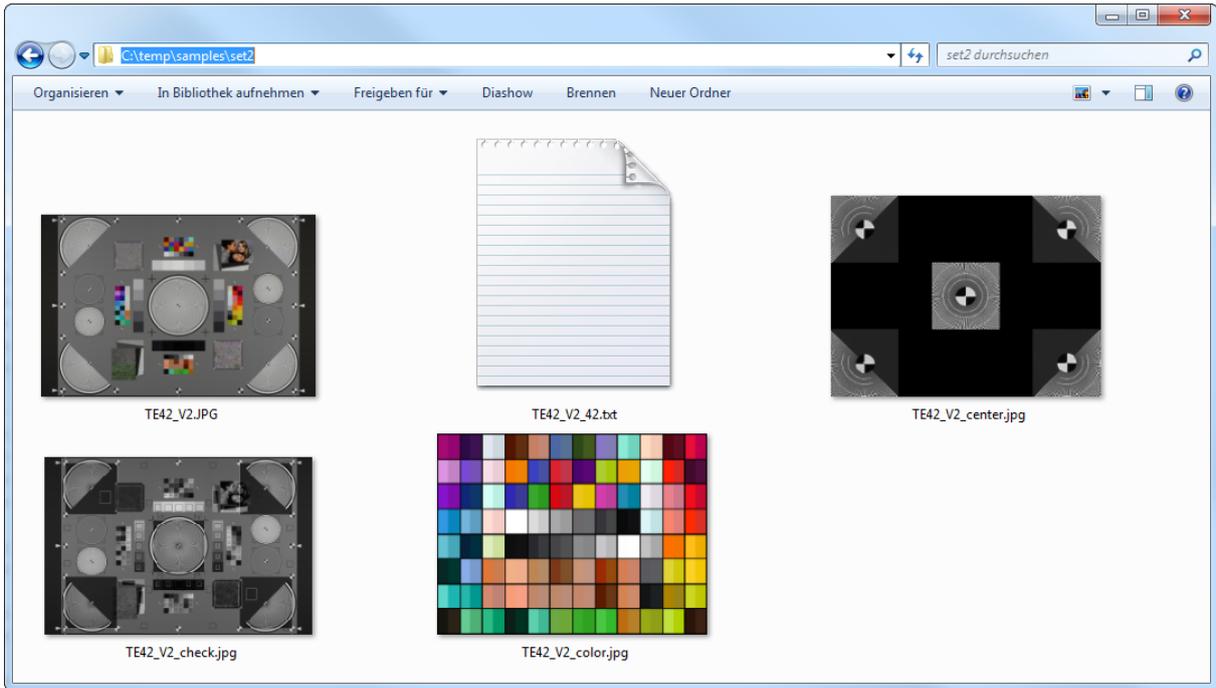
```
Administrator: C:\Windows\System32\cmd.exe
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iga6cmd.exe "C:\temp\samples\set2\TE42_V2.jpg" "
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Data\TE42_V2_Data.42" 42

iQ-Analyzer Command Line Version: 6.1.016

Start
Locate ROIs
Analyze
Calculate Results
C:\temp\samples\set2\TE42_V2.jpg:
-----
The defined luminance threshold of 245 is not reached. Using extrapolation to determine.

-----

Write Results
Done
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```





### Example 3 – Analyzing a single image file using human-readable text file settings

A sample settings text file IEA\_set.txt is shipped with your iQ-Analyzer distribution and is located in the subfolder “Setting” in the program directory by default. It consists of key/value pairs. Comments, beginning with the percent sign (%), will be ignored. Default comments in this file will give you an overview of possible values for a particular key. Instead of using the path to a .myset file as described in the first example, you must give the path to a .txt file as the second input parameter.

```
1  $ iQ-Analyzer
2  $ Setting-File
3  $
4  $ first draft
5  $
6  $
7  $ OECF
8
9
10 OECF.ChartLayoutFilePath      = Chart/TE241_OECF20.chart    % Chart Layout (path to .chart File)
11 OECF.ChartReferenceType      = ill2lum                    % Reference Data (ill2lum, direct or density)
12 OECF.CalcVisualNoise         = 1                          % Calculate Visual Noise (0 or 1)
13 OECF.RotateImage             = 0                          % 0, 90, 180, -90 degree 400 for horizontal flip, 500 for vertical flip
14 OECF.ScaleRange              = LayoutFile                 % "Layoutfile" or Range e.g. "0.2 - 0.5"
15
16 OECF.Processing              = Files in Queue             % "Files in Queue" or "File in Queue + Ext."
17 OECF.AverageMode             = Individual                  % "Average", "Individual", "Average + Individual"
18
19 OECF.DenFilePath             = Data/TE241_OECF20.den      % Density File (path to .den File)
20 OECF.Illumination            = 1000                          % Illumination in [lux]
21 OECF.LumFilePath            = Data/TE241_OECF20.lum    % Luminance File (path to .lum File)
22
23 OECF.Advanced.ThresholdDR    = 3                          % Threshold (DR)
24 OECF.Advanced.VNignore      = First / Last              % VN - Ignore for Mean ("First / Last", "First2 / Last2", "None")
25 OECF.Advanced.ColorNoiseC1  = 0.64                      % Color Noise Difference (C1)
26 OECF.Advanced.ColorNoiseC2  = 0.16                      % Color Noise Difference (C2)
27 OECF.Advanced.LimitSize.Enabled = 1                          % Limit Patch Size to <OECF.Advanced.LimitSize.Limit> Pixel (0 or 1)
28 OECF.Advanced.LimitSize.Limit = 50                          % [Pixel]
29 OECF.Advanced.CheckBackground = 1                          % Check Background (0 or 1)
30 OECF.Advanced.CheckNumSatPatch = 1                          % Check Number of saturated Patches (0 or 1)
31 OECF.Advanced.SaturationVariance = 0.001                     % Saturation is Variance < VALUE
32 OECF.Advanced.WarnNoFieldInSat = 1                          % Warn of no Field in Saturation (0 or 1)
33 OECF.Advanced.VersionOfISO   = ISO15739 V1                % "ISO15739 V1", "ISO15739 V2"
34 OECF.Advanced.TemporalNoise  = 0                          % Measure temporal noise (0 or 1)
35 OECF.Advanced.Ill2LumFactor  = 1                          % Illuminance to Luminance Factor
36
37
38 $ Color
39
40
41 Color.ChartLayoutFilePath    = Chart/TE230_ColorCheckerSG.chart    % Chart Layout (path to .chart File)
42 Color.RefFilePath           = Data/TE230_ColorCheckerSG.cref % Reference File (path to .cref File)
43 Color.Processing            = Files in Queue             % "Files in Queue" or "File in Queue + Ext."
44 Color.AverageMode           = Individual                  % "Average", "Individual", "Average + Individual"
45 Color.RotateImage           = 0                          % 0, 90, 180, -90 degree 400 for horizontal flip, 500 for vertical flip
46 Color.ScaleRange            = LayoutFile                 % "Layoutfile" or Range e.g. "0.2 - 0.5"
```

Syntax:

***iqa6cmd.exe <ImageFile> <TxtFile> <Module>***

Example:

***iqa6cmd.exe "C:\temp\samples\set3\TE268.JPG" "C:\Program Files (x86)\Image Engineering\iQ-Analyzer V6.1.016\Setting\IEA\_set.txt" resolution***



Result:

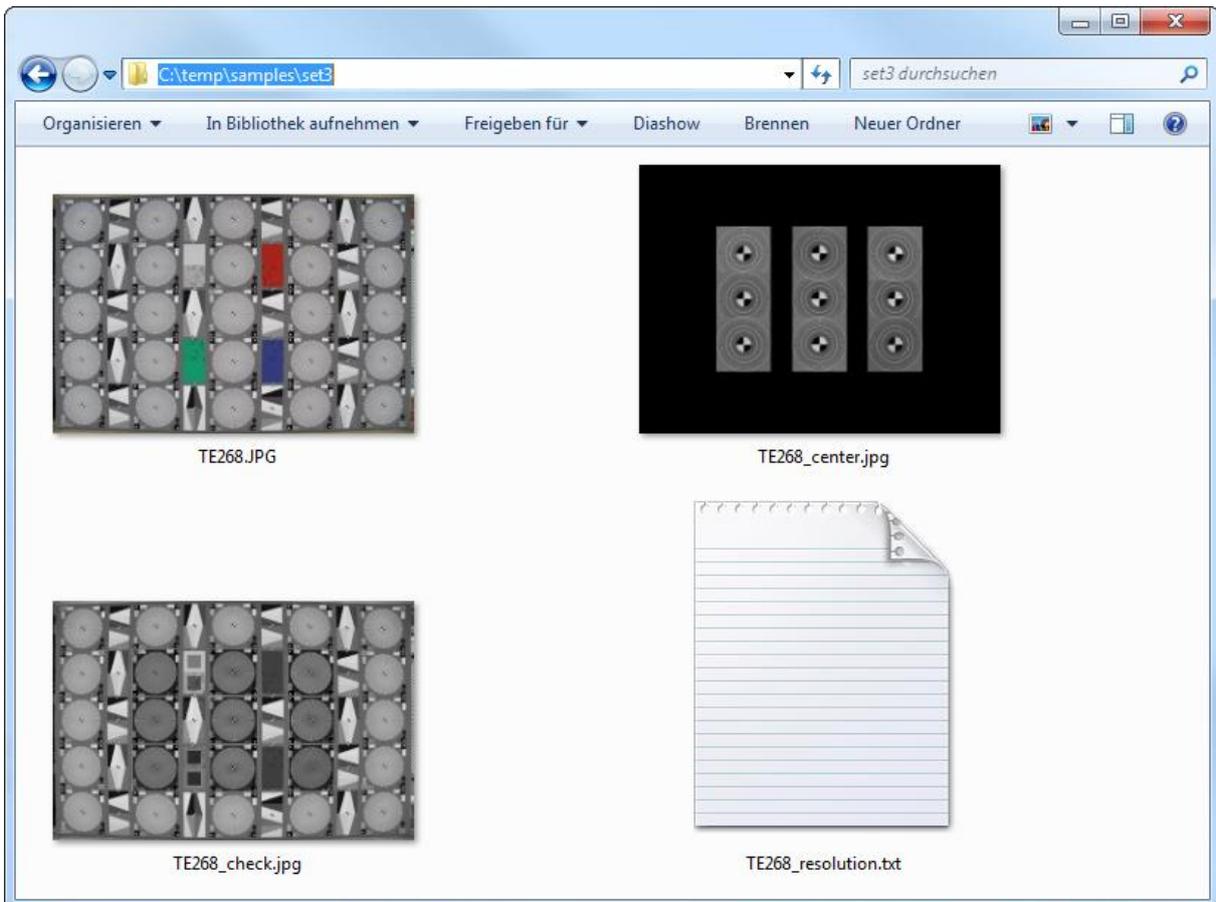
```
Administrator: C:\Windows\System32\cmd.exe

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iga6cmd.exe "C:\temp\samples\set3\TE268.JPG" "C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Setting\IEA_set.txt" resolution
Warning: application is running on a locale different from the original platform locale.

iQ-Analyzer Command Line Version: 6.1.016

Start
Locate Chart(s)      : . . . . .
Locate ROIs         : . . . . .
Correct ROIs        : . . . . .
Analyze             : . . . . .
Calculate Results   : . . . . .
Write Results       : . . . . .
Done

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```





#### Example 4 – Overriding settings by command line arguments

Instead of editing the whole settings file you can use default settings from a .myset file or create your own using the graphical user interface of iQ-Analyzer and override specific parameters. In order to do this you will need to pass the particular key and the desired value as command line arguments. You can refer to the list of all available parameters in the file IEA\_set.txt as described in the previous example.

Syntax:

***iqa6cmd.exe <ImageFile> < SettingFile > <Module> <Options>***

Example:

***iqa6cmd.exe "C:\temp\samples\set3\TE268.JPG" "C:\Program Files (x86)\Image Engineering\iQ-Analyzer V6.1.016\Setting\TE268\_default.myset" resolution Resolution.Edge.Calc 0  
Resolution.Noise.Calc 0 Resolution.Siemens.SubChart.All 0  
Resolution.Siemens.SubChart.Num "3 5 7 9"***

In this example following settings have been overwritten:

***Resolution.Edge.Calc 0*** (don't analyze any slanted edges)

***Resolution.Noise.Calc 0*** (don't analyze any Dead Leaves)

***Resolution.Siemens.SubChart.All 0*** (don't analyze all Siemens stars)

***Resolution.Siemens.SubChart.Num "3 5 7 9"*** (analyze only stars No. 3, 5, 7 and 9)

Please use quotation marks when passing values containing white spaces.



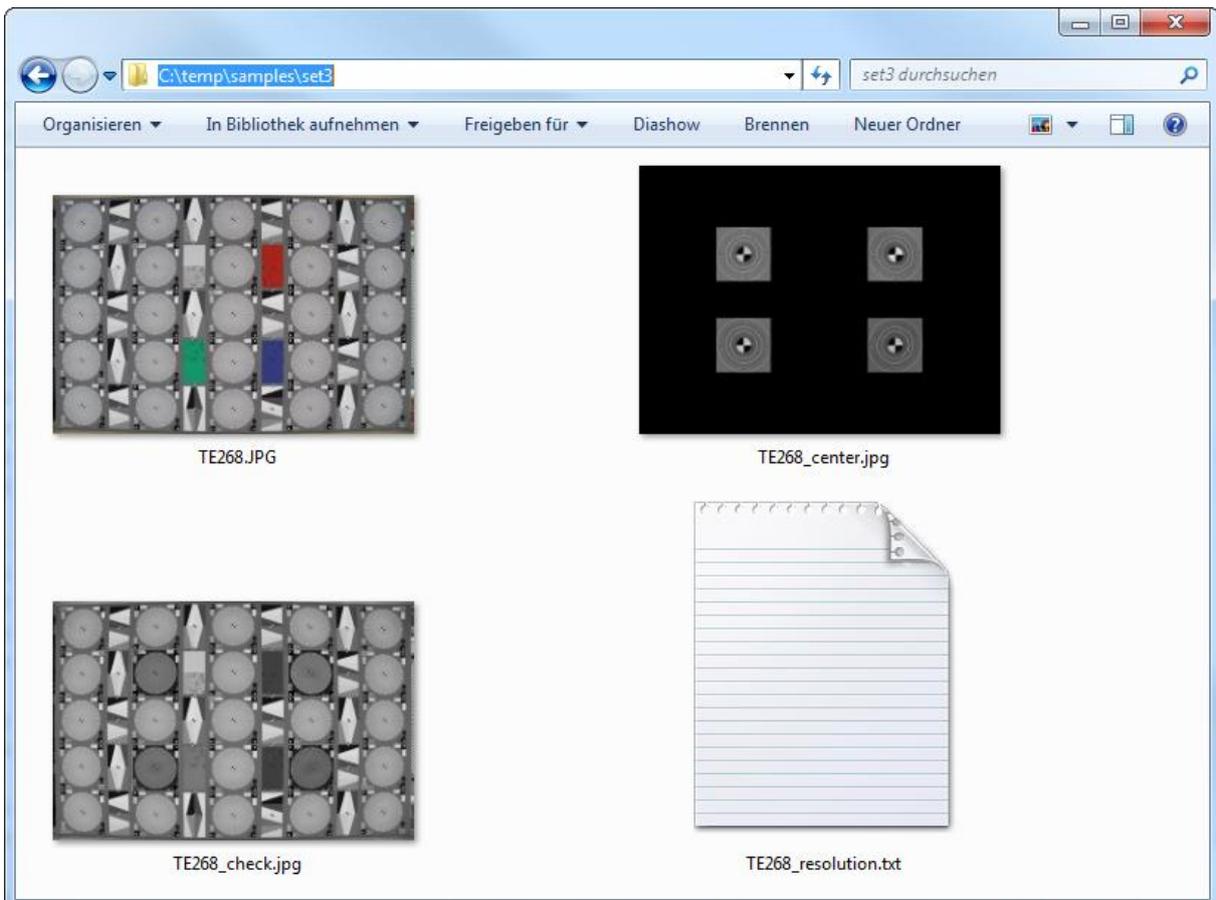
Result:

```
Administrator: C:\Windows\System32\cmd.exe
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iqa6cmd.exe "C:\temp\samples\set3\TE268.JPG" "C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Setting\TE268_default.myset" resolution Resolution.Edge.Calc 0 Resolution.Noise.Calc 0 Resolution.Siemens.SubChart.All 0 Resolution.Siemens.SubChart.Number "3 5 7 9"
Warning: application is running on a locale different from the original platform locale.

iQ-Analyzer Command Line Version: 6.1.016

Start
Locate Chart(s)      . . . .
Locate ROIs         . . . .
Correct ROIs        . . . .
Analyze             . . . .
Calculate Results   .
Write Results
Done

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```





### **Example 5 – Analyzing multiple files using wildcards**

You can use wildcards in order to analyze all image files matching a given pattern or with incrementing numbers. In this example three image files will be analyzed, TE241\_01.jpg, TE241\_02.jpg and TE241\_03.jpg.

Syntax:

***iq6cmd.exe <ImageFile> < SettingFile > <Module>***

Example:

***iq6cmd.exe "C:\temp\samples\set4\TE241\_\*.jpg" "C:\Program Files (x86)\Image Engineering\IQ-Analyzer V6.1.016\Setting\TE241\_ISO2003\_single.myset" oecf***



Result:

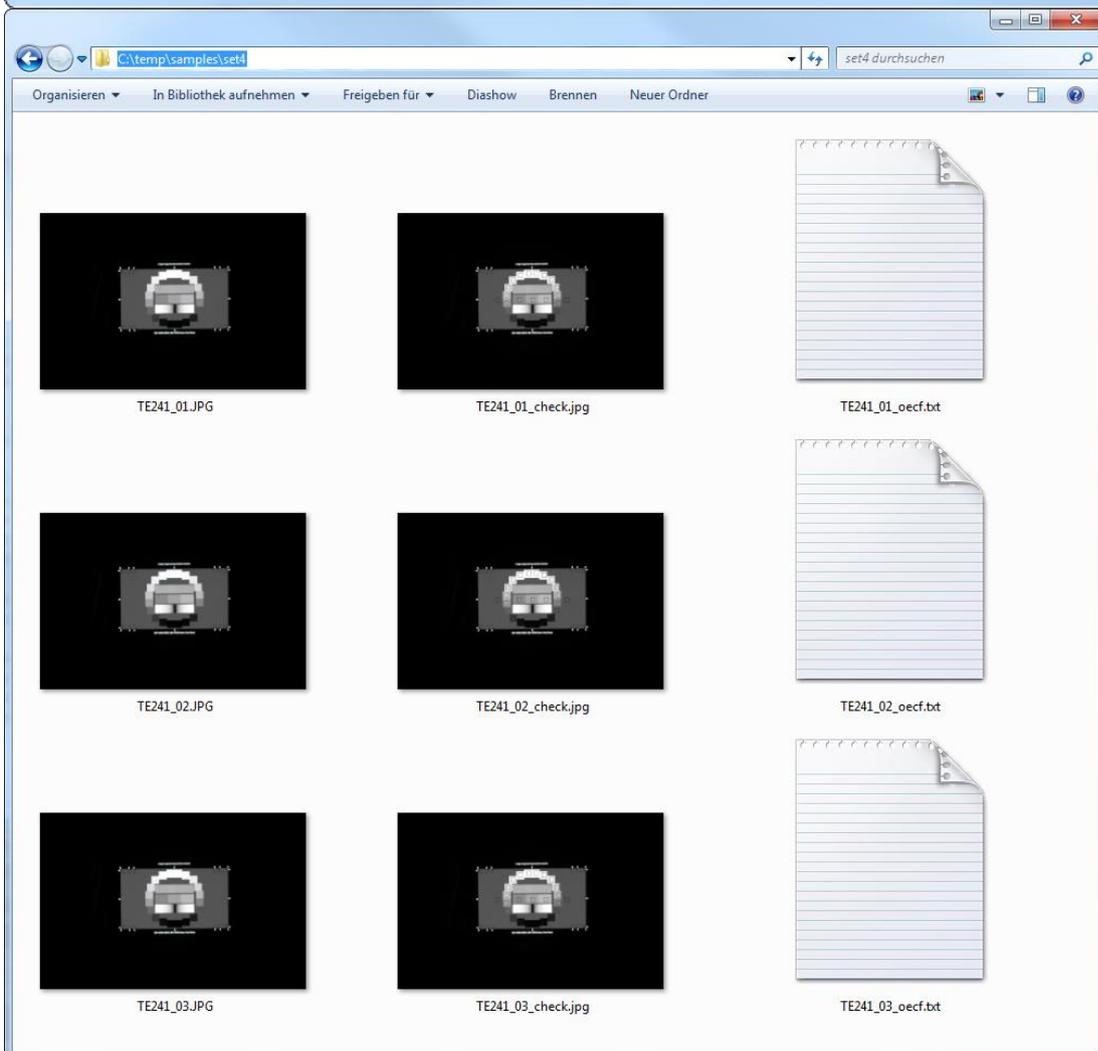
```
Administrator: C:\Windows\System32\cmd.exe

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iqa6cmd.exe "C:\temp\samples\set4\TE241_*.jpg" "C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Setting\TE241_ISO2003_single.myset" oecf
Warning: application is running on a locale different from the original platform locale.

iQ-Analyzer Command Line Version: 6.1.016

Start
Locate Chart(s)      . . .
Locate ROIs         . . .
Correct ROIs        . . .
Analyze             . . .
Calculate Results   . . .
Write Results
Done

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```





### **Example 6 – Using the interactive “input” mode**

In the previous examples, iQ-Analyzer is started and terminated every time a CMD command is issued. By using the interactive input mode you can start the program once for a specific combination of module and settings and then just input a full path to the image to be analyzed. When done, you can leave the interactive mode by typing exit in the CMD prompt.

In this example iQ-Analyzer was started in the OECF module with a setting for a single TE241 test chart. Then two images were analyzed, one at a time. At the end iQ-Analyzer was terminated by the exit command.

Syntax:

***iqa6cmd.exe input <SettingFile> <Module>***

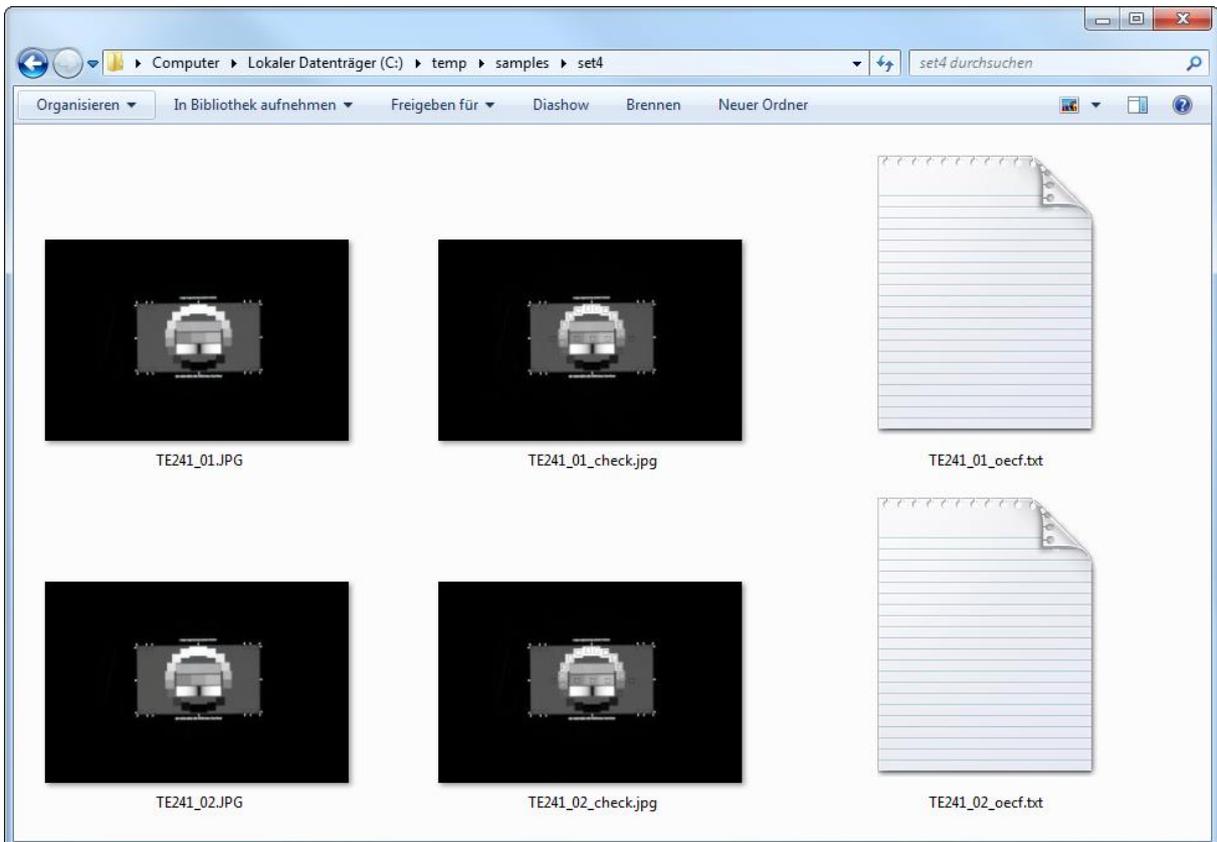
Example:

***iqa6cmd.exe input "C:\Program Files (x86)\Image Engineering\iQ-Analyzer  
V6.1.016\Setting\TE241\_ISO2003\_single.myset" oecf***



Result:

```
Administrator: C:\Windows\System32\cmd.exe
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iga6cmd.exe input
"C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Setting\TE241_ISO
2003_single.myset" oecf
Warning: application is running on a locale different from the original platform
locale.
INPUT: Enter single file to be analyzed:C:\temp\samples\set4\TE241_01.JPG
iQ-Analyzer Command Line Version: 6.1.016
Start
Locate Chart(s) .
Locate ROIs .
Correct ROIs .
Analyze .
Calculate Results .
Write Results .
Done
INPUT: Enter single file to be analyzed:C:\temp\samples\set4\TE241_02.JPG
iQ-Analyzer Command Line Version: 6.1.016
Start
Locate Chart(s) .
Locate ROIs .
Correct ROIs .
Analyze .
Calculate Results .
Write Results .
Done
INPUT: Enter single file to be analyzed:exit
STATUS: program exits due to "exit" command in file list.
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```





### Example 7 – Using the “input” mode with a file list

Instead of typing the file paths every time, you can create a text file containing a file path to the image in each line and pass it to the command line interface in one call using the < operator. In the last line of this file you must terminate the program with the exit command.

Here is an example of such a list file:

```
C:\temp\samples\set4\list.txt - Notepad++
File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X
list.txt x
1 C:\temp\samples\set4\TE241_01.JPG
2 C:\temp\samples\set4\TE241_02.JPG
3 exit
length: 74 Ln: 1 Col: 1 Sel: 0 | 0 Dos\Windows UTF-8 INS
```

Syntax:

***iq6cmd.exe input <SettingFile> <Module> < <ListFile>***

Example:

***iq6cmd.exe input "C:\Program Files (x86)\Image Engineering\IQ-Analyzer  
V6.1.016\Setting\TE241\_ISO2003\_single.myset" oecf < "C:\temp\samples\set4\list.txt"***



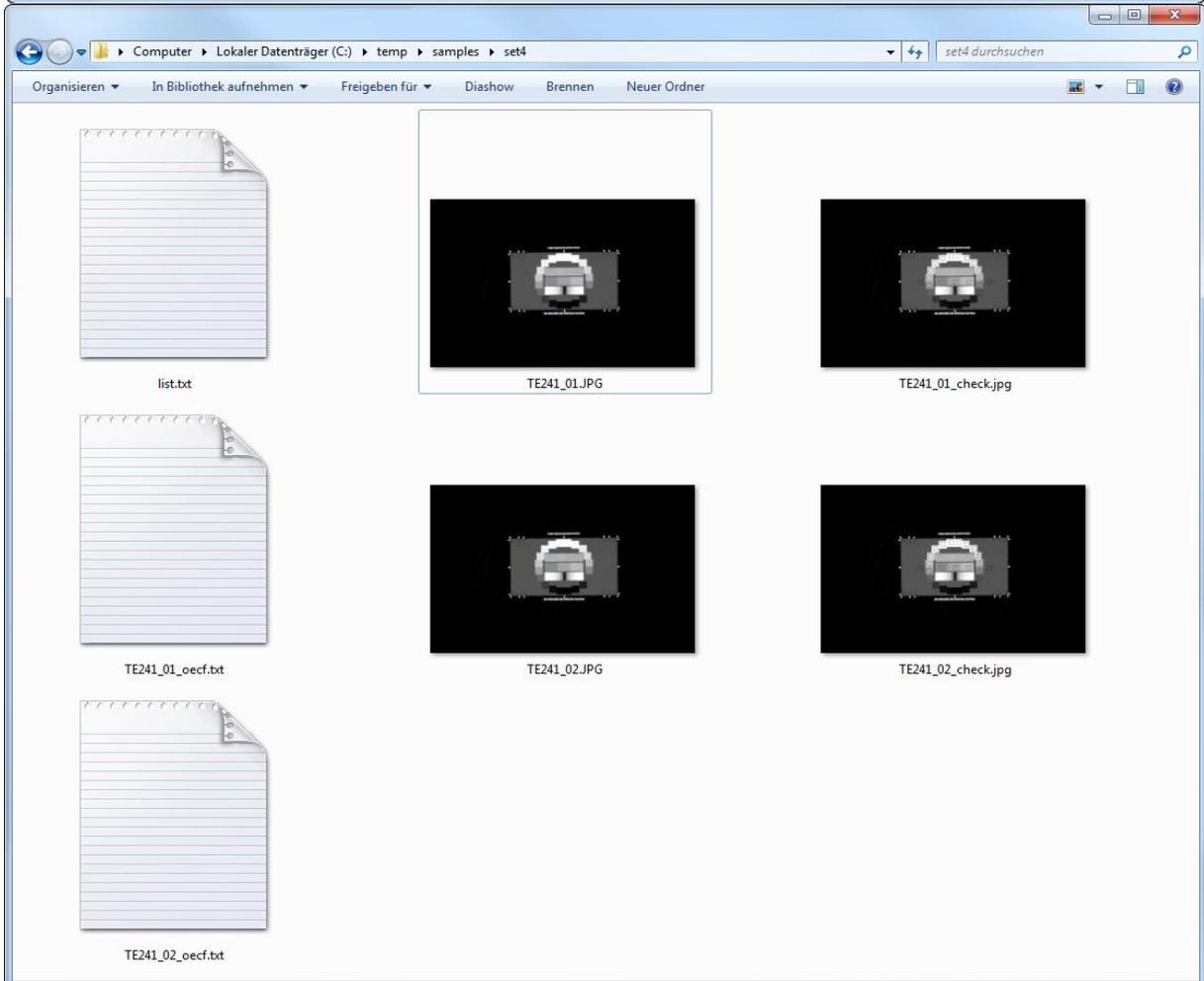
Result:

```
Administrator: C:\Windows\System32\cmd.exe
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iga6cmd.exe input
"C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Setting\TE241_ISO
2003_single.myset" oecf < "C:\temp\samples\set4\list.txt"
Warning: application is running on a locale different from the original platform
locale.
INPUT: Enter single file to be analyzed:
iQ-Analyzer Command Line Version: 6.1.016

Start
Locate Chart(s)      .
Locate ROIs          .
Correct ROIs         .
Analyze              .
Calculate Results    .
Write Results        .
Done
INPUT: Enter single file to be analyzed:
iQ-Analyzer Command Line Version: 6.1.016

Start
Locate Chart(s)      .
Locate ROIs          .
Correct ROIs         .
Analyze              .
Calculate Results    .
Write Results        .
Done
INPUT: Enter single file to be analyzed:STATUS: prgram exits due to "exit" comma
nd in file list.

C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```





### **Example 8 – Using the “observe” mode continuously monitoring a file list**

As shown in the previous example, you can create a file list and use it as input for the command line interface of iQ-Analyzer. In addition to creating this list statically, you can use any other tools to fill the contents of the file list dynamically. In the “observe” mode iQ-Analyzer once every second reads the contents of the list and analyzes a file when a new entry is found. When iQ-Analyzer is done with a file from this list, it will delete the entry. The program can be terminated by putting the command exit into the file list. Unless you want to terminate the program there always must be a last line containing the command wait, telling the software to remain in the “observe” mode like in the example below.

The following example shows the contents of the text file and the corresponding output of iQ-Analyzer.

Syntax:

***iqa6cmd.exe observe <SettingFile> <Module> <ListFile>***

Example:

***iqa6cmd.exe observe "C:\Program Files (x86)\Image Engineering\iQ-Analyzer  
V6.1.016\Setting\TE241\_ISO2003\_single.myset" oecf "C:\temp\samples\set4\list\_observe.txt"***



Result (waiting for input):

```
C:\temp\samples\set4\list_observe.txt - Notepad++
File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X
list_observe.txt x
1 wait
2
length: 5 Ln: 2 Col: 1 Sel: 0 | 0 Dos\Windows ANSI INS
```

```
Administrator: C:\Windows\System32\cmd.exe - iqa6cmd.exe observe "C:\Program Files (x86)\Ima...
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>iqa6cmd.exe observe
e "C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016\Setting\TE241_I
S02003_single.myset" oecf "C:\temp\samples\set4\list_observe.txt"
STATUS: Opening file list.
STATUS: Closing file list.
```



Result (analyzing a file):

```
C:\temp\samples\set4\list_observe.txt - Notepad++
File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X
list_observe.txt x
1 C:\temp\samples\set4\TE241_01.JPG
2 wait
length: 39 Ln: 1 Col: 34 Sel: 0 | 0 Dos\Windows ANSI INS
```

```
Administrator: C:\Windows\System32\cmd.exe - iqa6cmd.exe observe "C:\Program Files (x86)\Ima...
STATUS: Opening file list.
STATUS: Closing file list.
STATUS: Opening file list.
STATUS: Closing file list.
STATUS: Opening file list.
STATUS: Closing file list.
iQ-Analyzer Command Line Version: 6.1.016
Start
Locate Chart(s) .
Locate ROIs .
Correct ROIs .
Analyze .
Calculate Results .
Write Results .
Done
STATUS: Opening file list.
STATUS: Closing file list.
```



Result (terminating):

The image shows two windows. The top window is Notepad++ with the file 'list\_observe.txt' open. The content of the file is:

```
1 exit
2
```

The bottom window is a Windows command prompt running as Administrator. It shows a loop of opening and closing a file named 'list'. The output is:

```
STATUS: Closing file list.
STATUS: Opening file list.
STATUS: Closing file list.
STATUS: Closing file list.
STATUS: program exits due to "exit" command in file list.
C:\Program Files (x86)\Image Engineering\iQ-Analyzer U6.1.016>
```



## 4 GRAPHICAL USER INTERFACE

This chapter provides a brief introduction about the structure of the user interface.

### 4.1. HOME SCREEN

The Home screen provides a simple user interface for operators. It is reduced to the most important settings for repeating tasks as well as the main functions. The simplified user interface is useful if your workflow is based on limited number of charts and settings. You can adjust the shown modules, charts and settings to your needs in the Setting menu.



Figure 1 iQ-Analyzer Home screen

#### 4.1.1. Main functions

The main functions in top of the screen enable navigating to the different functions and modules:

*Input functions:* RAW and Meta are only available using the administrator mode

*Modules:* The dropdown menu is available after the analysis to switch between the modules and see the results. Choose between *Home, OECF, Color, Resolution, Shading, Distortion, Histogram, Flare, 42, UTT, Measurement or Video.*

*Lock (key symbol):* Enables the administrator functions

*Requirements:* Set individual limits and tolerances to classify your results. This feature is only available in administrator mode.

*Import/Export:* This menu contains adjustments for the export of graphical data. It is only available in administrator mode.



**General Settings:** The settings menu contains all general settings. It is only available in administrator mode.

**Version/Build:** Information about the installed iQ-Analyzer version

#### 4.1.2. Operator workflow (Home screen only)

Starting the iQ-Analyzer Version 6 will lead you to the *Home* screen. It takes a while until the MCR (MatLab component runtime) starts and the iQ-Analyzer *Home* screen appears.

##### Step 1: Choose module

Select the module in which you want to do evaluations with by clicking on it. This limits the available chart layouts in the next step to the ones related to this module. If you do not make this selection (remain with default „All“) all available chart layouts are displayed.

##### Step 2: Choose chart

Choose the appropriate chart layout from the middle column. The thumbnails of the charts and the chart name will help you to pick the right one.

##### Step 3: Choose settings

In the right column all predefined settings appear, which are deposited for the selected chart layout. Choose the one matching to the analysis you want to do.

##### Step 4: Choose files

Use „+“ at the bottom of the table to add a file to the list. A new window opens where you can navigate to the folder your test images are stored in and select one or more images. These files are now shown in the list. The filename is displayed followed by the appropriate chart layout and setting you have chosen in step 2 and 3. For adding more files to the list click again the „+“-button.

To add files containing other test patterns start again with step 1. Choose the appropriate chart layout (step 2), the setting (step 3) and add files to the list (step 4). You can delete files of the list by clicking on the „-“ symbol.



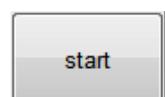
If you like to change any setting of a listed image file, select this file in the list. It will be marked in blue. Then make a new selection for step 1 to 3 and confirm with the button „*apply*“. The information next to the filename will change to your actual selection.



You can review the settings for each file by having a look at the filelist or by selecting a file from the list. The selected module, chart and setting is marked with a blue frame.

##### Start analysis

Press the „*Start*“ button to start the analysis.





## Display results

When the software has done the calculation the view switches to the module the test pattern belongs to. If you choose test patterns of different modules the results are displayed in these different modules. Switch to another module by selecting it from the above drop down menu. The result and check images are stored automatically in the folder defined in the settings menu. You can change the graphical representation of the results in many ways. For detailed information refer to chapter 6.

The results can be stored as .iea file (iQ-Analyzer format). You can load .iea files to review the numerical results and the graphical representations. How to use this option is described in chapter 5.4 Export/Import.

## Further Analysis

If your analysis is finished go back to the iQ-Analyzer *Home screen* to start a new measurement by selecting „Home“ from the drop down menu.

### 4.1.3. Administrator workflow

As administrator you prepare the whole analysis for the operators which afterwards just have to choose the predefined settings and start the analysis. Following this principle you can ensure that all operators apply the same settings. All of your results will be absolutely comparable at any time. To switch to administrator mode click on the button with the key symbol.



## CHART LAYOUT FILES

The iQ-Analyzer *Home* contains default chart layouts. The chart layout files are created by Image Engineering. The chart layout files are stored as .chart files in the folder:

C:\ProgramData\Image Engineering\iQ-Analyzer V6.X.X\Chart

To add a new layout to the iQ-Analyzer *Home* first add the layout file to the defined folder. Now it is available in the selection of chart layouts of the module (when using the administrator mode). Secondly add this layout to the iQ-Analyzer *Home* by using the „Manage Home“ function in the *General Settings*. For details please refer to chapter 5.5.7.

## SETTINGS FILES

The iQ-Analyzer *Home* offers default settings for the available chart layouts and example images delivered with the iQ-Analyzer software. Please create individual settings according to your needs by doing all adjustments in the regarding modules and store these settings using the menu „Settings & Start Up“ in the *General Settings* menu. Settings will be stored as .myset files in the default folder:

C:\ProgramData\Image Engineering\iQ-Analyzer V6.X.X\Setting

Now this new settings file is available when using the administrator mode. To add it to the iQ-Analyzer *Home* use the „Manage Home“ function under *General Settings*. For details please refer to chapter 5.5.7.



## 4.2. STANDARD MODE / MODULES

The main functions at the top of the window are consistent with the *Home* screen. The *Import/Export* menu and the *General Settings* menu are enabled when using the administrator mode. Switching to any module except the *Home* screen the input functions *RAW* and *Meta* and the *Settings* are also available.

The workspace is organized in four columns:

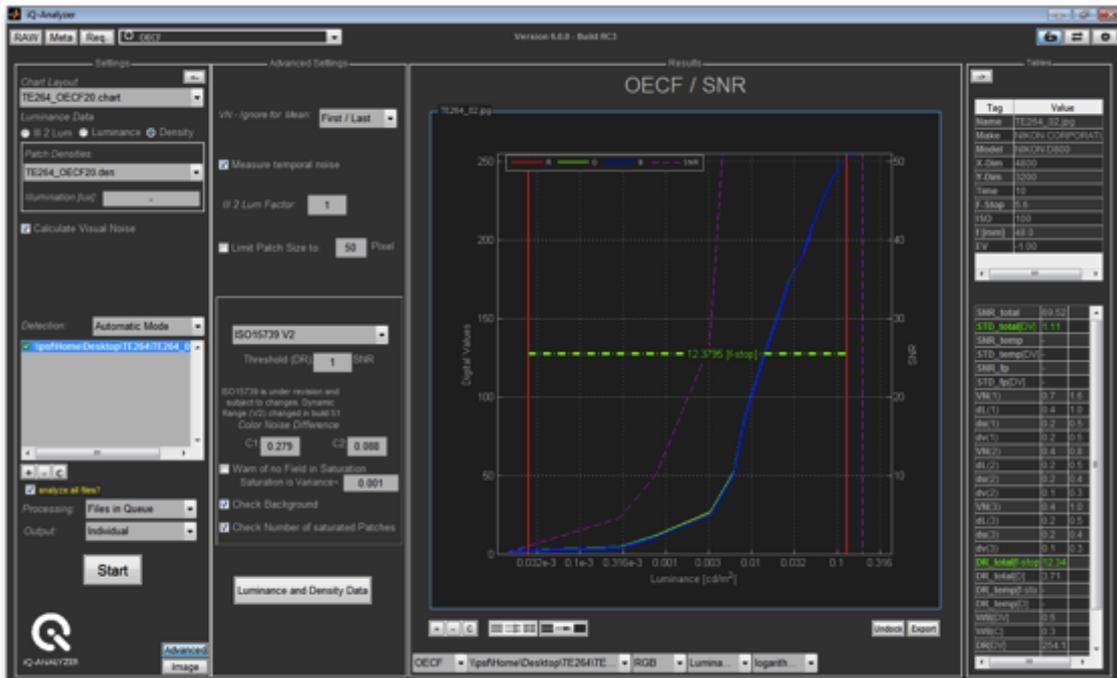


Figure 2 Structure of the iQ-Analyzer workspace

**Settings:** The left column contains the *General Settings* and the filelist. This column can be hidden or displayed by clicking on the arrow. Using the operator mode all functions concerning image calculations are disabled.



**Advanced Settings:** On the right of the settings the advanced settings will be displayed and hidden (only in administrator mode). They contain more specified settings regarding the calculation.

**Results:** The most prominent column shows the graphical presentations of the results. The view could be adjusted by the drop down menus at the bottom.

**Tables:** On the right side the fourth column can be displayed which contains tables with the numerical results. This column can also be displayed and hidden by the arrow button.

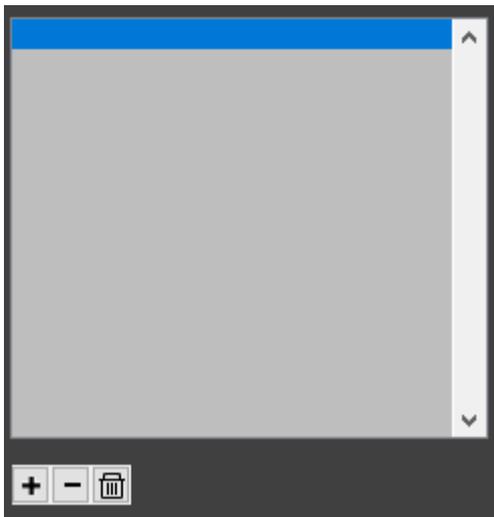


## 5 IMPORT, GENERAL SETTINGS AND REQUIREMENTS

The iQ-Analyzer contains different modules to specify import settings and to adjust the analysis and output settings.

### 5.1. RAW

RAW images are added to the file list similar to processed images. You can add a file for analysis to the file list using the “+” button.



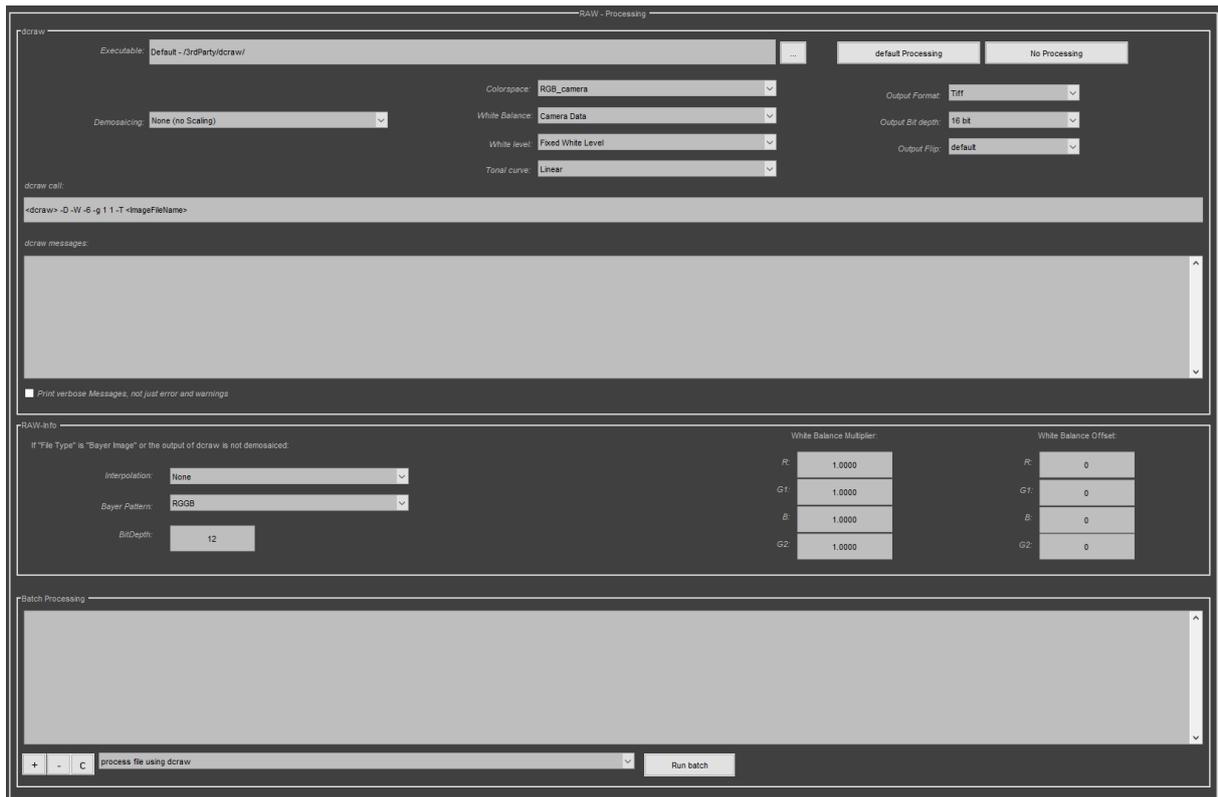
In the Open File Dialog you can change the image type compliant to the raw image. The available options are dcrw Input Files, Bayer Image files, Bitstream Files or just All Files.



By changing the file type iQ-Analyzer is triggered to check and execute the settings within the RAW module. Delete selected files with the “-“ button and clear the list with the “C” button.

To change the import settings for your image you need to switch to the RAW module.





### 5.1.1. RAW Processing

#### Executable

This is the location of the dcrw executable which is applied for converting the images. Its default location is in the programm folder in /3rdParty/dcrw, but you can choose a different folder if you like. For example, if you want to use a different version of dcrw.

#### Default Processing

Loads the default processing settings for raw images.

#### No Processing

Deactivates options which affect the image data, for example, demosaicing, colorspace or white balance. The white level will be fixed and the tonal curve processed linear. The image output options will be set to Tiff, 16 bit and default output flip.

#### Dcrw Settings

The iQ-Analyzer provides a quick access to some of the most important options that will be applied when calling dcrw. As dcrw is a 3<sup>rd</sup> party product, please check the manpage of dcrw for details about the different options.

Manpage of dcrw: <http://www.dechifro.org/dcrw/dcrw.1.html>



### **Dcraw call**

The comand line parameters which can be adjusted are defined on the dcraw manpage. The generated dcraw command is displayed in the “dcraw call”. This call will change according to the settings in the dialog. In the “presets” standard configurations are stored. Imported raw images will be processed with the choosen settings before analysis.

### **Print verbose Messages, not just errors and warnings**

If this checkbox is marked the raw processing steps are listed more detailed.

## **5.1.2. RAW-Info**

If the image to be processed is one without demosaicing (Bayer image) or the output of dcraw is an image without demosaicing, the image is further processed.

### **Interpolation**

Option to define if the image shall be demosaiced or not.

*None:* The image is handled as an RGB+G2 Image for analysis.

*Gradient Corrected linear:* If an interpolation algorithm is selected, the image is demosaiced.

### **Bayer Pattern**

Define the Bayer Pattern of the sensor. Each string represents the order of the red, green, and blue filtered pixels by describing the four pixels in the upper-left corner of the image (left-to-right, top-to-bottom).

### **BitDepth**

Define the BithDepth of the RAW Data.

### **White Balance Multiplier**

The values are multiplier for each channel of the sensor data. If this is different than "1", you can change the slope of the channel and therefore make a white balancing on the data. To get this data, you can run dcraw with the options "-i -v" to get informations about the file. Note: The data might be stored differently in the different raw-files. Most likely you need to normalize the data to the green channel.

### **White Balance Offset**

The dark current might vary for the different channels. The offset will be added to each channel before the multiplier is applied to the data. The offset can also be negative.



### 5.1.3. Batch Processing

You can add image files to the raw processing with “+”, delete them with “-“ and clear the list with “C”. Select between “*Process file using dcraw*” and “*Process file using dcraw, make RGB if still bayer image*” and press “*Run batch*”.



## 5.2. META

The meta data of the image files is read out and displayed in the *Meta* module which can be opened by pressing the Meta button in the top left corner. You can add or change data in this dialog. Some information in the “*Image Properties*” like color space and image direction is used for the image analysis. In the result text file all meta data is integrated in the header if this option is activated in the settings.

Figure 3 Meta data dialog

### 5.2.1. Device

This section shows information about the device. The pixelpitch can be calculated by inserting values for image width and height in mm and pressing the enter key.

### 5.2.2. Image Properties

#### Rotate

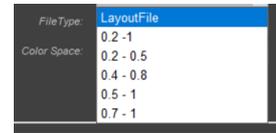
In the dropdown menu you can choose to rotate or flip images if necessary. The image must have landscape orientation and show the proper side for analysis.



## Chart Height

The dropdown menu enables you to define the pattern size related to the image height to reduce calculation time. The smaller the range the faster is the detection. A value of “1” means, that the pattern fills 100% of the image height. A value of “0.1” means, the pattern fills 10% of the image height. A centered pattern is required.

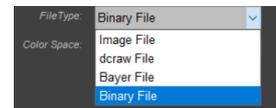
Example: The pattern has a height of 300 pixel in an image of 1280 x 960 pixel. As the scale is 0.3125 you need to select “0.2-0.5”. If you have several pictures with different sizes of the pattern related to the image height, choose “0.2-1”. “LayoutFile” is the default setting and uses the size defined in the layout file.



## File Type

Depending on the imported image file the file type is indicated in the dropdown menu.

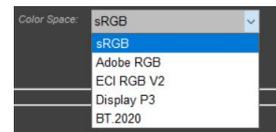
- Image File:* standard image file like .jpg, .png,...
- RAW File:* unprocessed, demosaiced file, delivered for example by consumer cameras
- Bayer File:* undemosaiced image data with Bayer pattern
- Binary file:* binary file



## Color Space

For color calculations RGB values are converted to XYZ. Select a profile that is used for conversion.

- Default Profiles:* choose one of the default profiles sRGB, Adobe RGB, ECI RGB V2, Display P3 or BT.2020
- Embedded Profile:* uses the Profile, embedded in the image
- Select Profile:* select a profile installed at your PC



## Aperture

Aperture according to camera information.

## Time [s]

Exposure time of the image.

## ISO Speed

The ISO speed is calculated by inserting values for “Aperture” under Image Properties, “Object Distance [m]” under Setup and pressing the enter key.

## Focal length

Focal length according to camera information.



### **Aperture (effective)**

If “*Aperture*” under Image Properties and “*Object Distance [m]*” under Setup is available the effective aperture is calculated. Insert data and press enter key.

### **Exposure Bias**

Shows information about exposure compensation.

## **5.2.3. Setup**

Contains information about laboratory setup and operator.

### **Illumination [lux]**

Insert information about the intensity of the illumination (optional).

### **Object Distance [m]**

The distance to the object is required to calculate ISO Speed and the effective aperture.

### **Laboratory**

Optional information about the executing laboratory.

### **Operator**

Optional information about the executing operator.

## **5.2.4. Notes**

Here you can insert your notes which are also displayed in the result text file.

### **Apply changes to all files in list**

If the checkbox is marked the meta settings are applied to all files in the list of the active module when you press the update button.





### 5.3. REQUIREMENTS

In the *Requirements* menu you can define limits or ranges for different parameters. This feature facilitates an immediate assessment if a result is in or out of your tolerances.

The requirements will be displayed in the numerical results as red, yellow and green values and in suitable graphical representations.



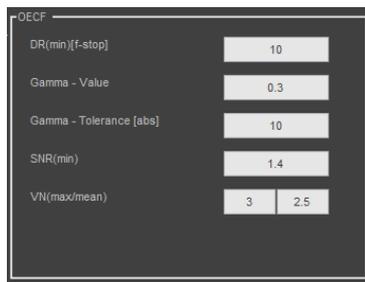
Requirements tab

You can open the *Requirements* menu by clicking on the toggle button in the top right corner. Activate the checkboxes for one or more module and adjust the limits to your needs.

Note: Active requirements will be included when you save the settings.

#### 5.3.1. OECF

- DR (min) [f-stop]:* Minimum dynamic range, graphical presentation see logarithmic OECF plots
- Gamma-Value:* Aimed gamma function; graphical presentation see linear OECF plots
- Gamma-Tolerance[abs]:* Tolerance for the required gamma function, graphical presentation see linear OECF plots
- SNR (min):* Minimum SNR value
- VN (max/mean):* Set a maximum and mean value for visual noise



SNR_total	54.48	
STD_total[DV]	1.36	
SNR_temp	-	
STD_temp[DV]	-	
SNR_fp	-	
STD_fp[DV]	-	
VN(1)	1.0	1.7
dL(1)	0.6	1.1
du(1)	0.3	0.6
dv(1)	0.3	0.6
VN(2)	0.5	0.9
dL(2)	0.3	0.5
du(2)	0.2	0.4
dv(2)	0.1	0.3
VN(3)	0.6	1.0
dL(3)	0.3	0.5
du(3)	0.2	0.4
dv(3)	0.1	0.3
DR_total[f-stop]	12.06	
DR_total[D]	3.63	
DR_temp[f-sto	-	
DR_temp[D]	-	
WB[DV]	0.6	

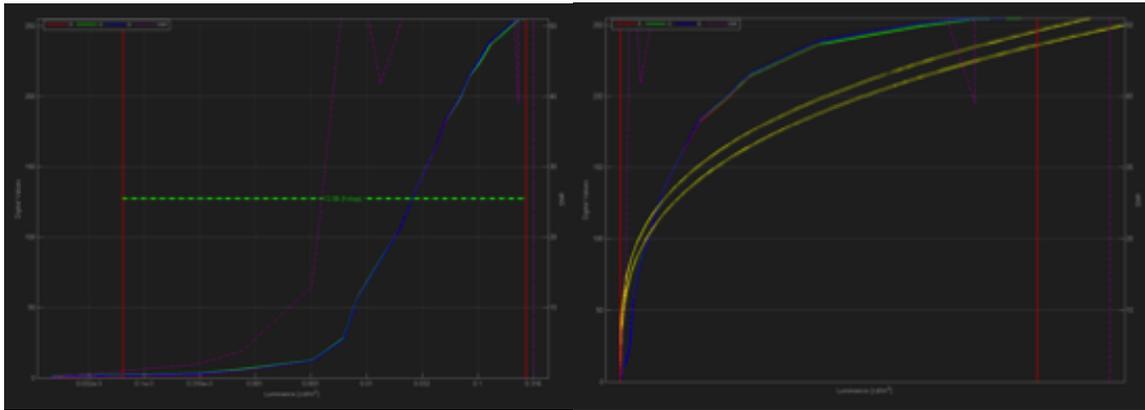


Figure 4 Dynamic range limit and gamma requirement/tolerance



### 5.3.2. Color

$dE$  (max/mean):

Define a mean and a maximum value for the color difference  $\Delta E$ . The limits will be applied to the different groups of patches. A value will become green if all groups are in the tolerances, red, if all groups are outside of the tolerances and yellow if some groups are inside and other outside of the tolerances.

	All	Neut...	Color
$\Delta E(\text{mean})$	6.7	1.5	8.4
$\Delta L(\text{mean})$	-0.8	-0.2	-0.9
$\Delta C(\text{mean})$	-4.9	-0.3	-6.4
$\Delta H(\text{mean})$	-0.4	-0.2	-0.5
$\Delta E(\text{max})$	14.0	2.0	14.0
$\Delta L(\text{max})$	1.7	1.7	1.7
$\Delta C(\text{max})$	1.8	1.3	1.8
$\Delta H(\text{max})$	6.0	0.2	6.0

$dL$  (max/mean):

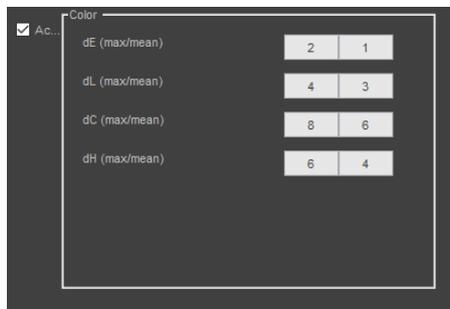
Define limits for differences in luminance.

$dC$  (max/mean):

Define limits for differences in chrominance.

$dH$  (max/mean):

Define limits for differences in hue.



### 5.3.3. Resolution

Limit (min) [LP/PH]:

Define a minimum resolution for the resolution measurement using Siemens stars. The limit is displayed in the numerical results for each star, segment or group. A gray dotted line marks the limit in the MTF plot.

	Star0	Star1	Star2
<b>MTF[LP]</b>	<b>1192</b>	<b>969</b>	<b>1030</b>
MTF25	1029	820	867
MTF50	757	577	596
MTF [%]	47.4	34.9	36.8
vMTF	60.5	48.2	49.7
vMTF	83.5	76.1	76.0
vMTF	79.1	70.1	70.4

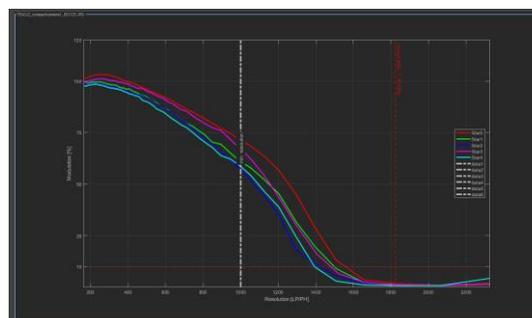


Figure 5 Resolution limit in the Siemens/MTF stars view



### 5.3.4. Shading

*Shading (max) [f-stop]:*

*Perfect, good,*

*acceptable below:*

Set the tolerance for shading in f-stops.

Define more precise ranges using *perfect*, *good* and *acceptable below* in f-stops. The ranges are displayed in the “Chromaticity” view as boxes.

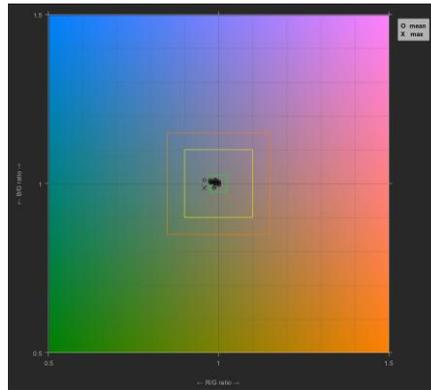


Figure 6 Chromaticity plot

### 5.3.5. Distortion

*LocalGD worst fit (max):*

The worst fit defines a range within the lens geometric distortion is acceptable. It is displayed in the “vs field” view.

<b>Distortion</b>	
TV EBU[%]	0.2
TV SMIA[%]	0.4
<b>Distortion</b>	
LGDmean	0.1
LGDworst	0.5
LGDworst(fit)	0.4
<b>Chrom.Ab.</b>	
CA GR mean	0.17
CA GR max 10	0.41
<b>Chrom.Ab.</b>	
CA GB mean	0.07

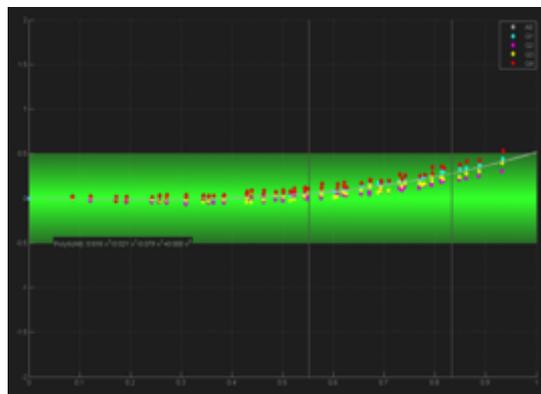


Figure 7 “VS Field” view and tolerance range



## 5.4. EXPORT/IMPORT

In the Export/Import menu you can make settings for saving results and graphs.



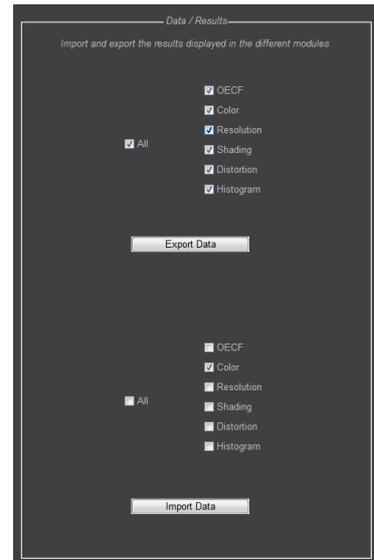
Export/Import tab

### 5.4.1. Data / Results

The results of all or individual modules (if calculated) are saved in a .iea file, an iQ-Analyzer-internal file format.

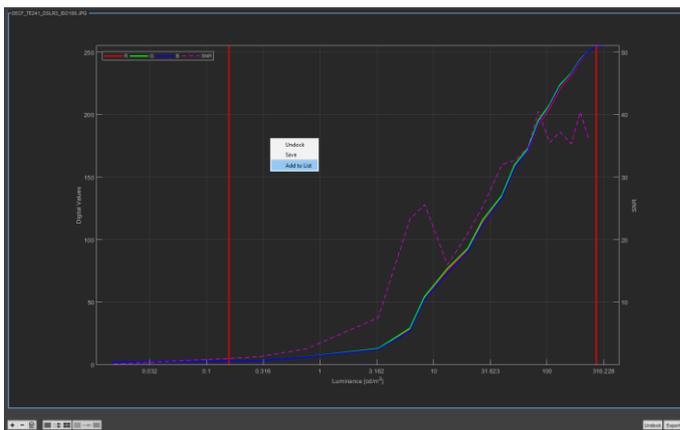
Select the modules you like to save using the checkboxes and press “Export Data”. The files will be saved in the export folder which is defined in the settings dialog.

You can also import the results to the iQ-Analyzer to use the graphical representations and to do further analysis. Select the modules by using the checkboxes and press “Import Data”. A window will open where you can navigate to your file and open it.



### 5.4.2. Export Graphics

The result graphs can be saved either individually in every module by using the “Export” button (refer to chapter 6.2.3) or the graphs can be collected first and then exported altogether using the “Graphics” menu.



To add a graph to the list right click on it and press “Add to list”. Now the graph appears as record in the current list. The first list is an empty one called “BLANK.plotset”. Graphs of all modules can be combined in the list.

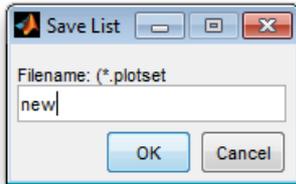


A graph can be removed from the list by selecting it and then pressing the “-“ button, the entire list by using the trashcan.



### Save List / plotsets

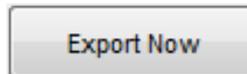
The actual list could be saved using the „+“ button. Name the file individually and click „Ok“. The actual list is now contained in the dropdown menu.



This list of data plots can be applied to export the results of other images.

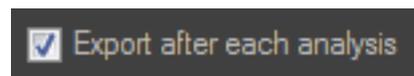
### Export Now

By using the „Export Now“ button the listed graphs are saved. File path and file format are defined in chapter 5.5.1 Output.



### Export after each analysis

The checkbox „Export after each analysis“ enables the automatic export of the graphical results according to the selected plotset when an analysis is finished.





## 5.5. GENERAL SETTINGS

In the *General Settings* menu all important parameters regarding visual noise, output and general parameters such as file path to reference data can be adjusted.



General settings tab

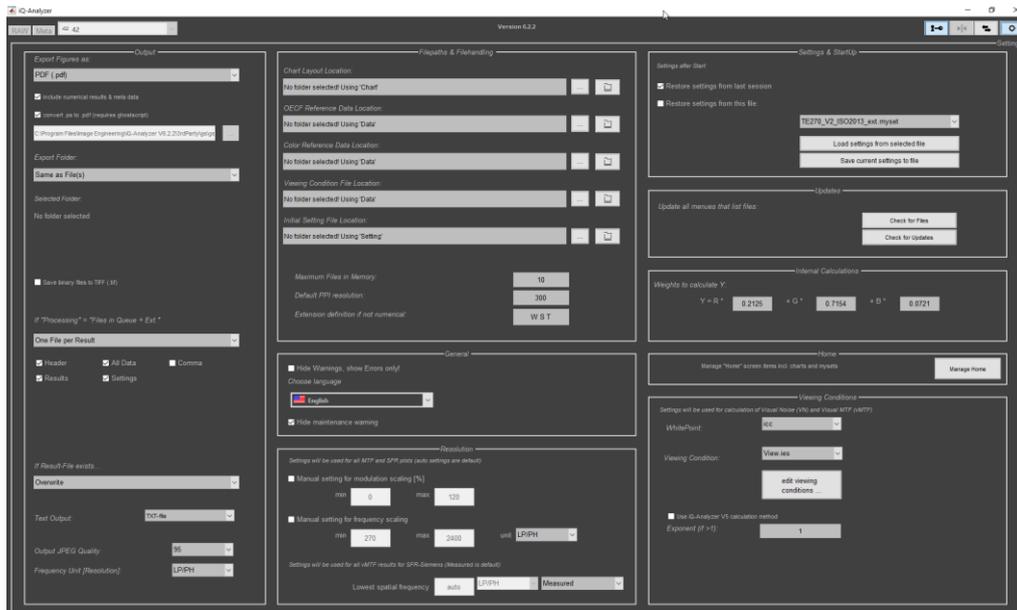


Figure 8 General Settings overview

### 5.5.1. Output

The iQ-Analyzer since version 6 is able to export PDF files as well. Required for this feature is the installation of ghostscript, which is an interpreter for the PostScript language and for PDF.

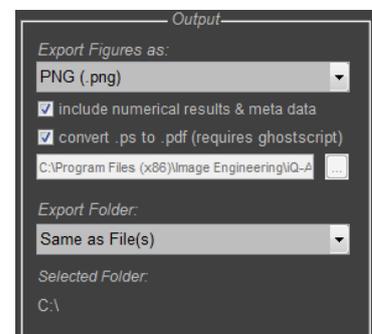
The software is contained in the 3rd party folder of the iQ-Analyzer software.

For more information concerning ghostscript see official webpage <http://www.ghostscript.com/>

#### Export figures as

Apart from the numerical results in text and XML files, the iQ-Analyzer offers the export of reports. Select the file format of exported figures: PS, PDF or PNG.

*Include numerical results:* If *include numerical results & meta data* is selected, the reports contain also the numerical results and the meta data.



output properties



*Convert .ps to .pdf:*

Enable this function to receive an pdf file as output. The path to the folder containing the ghostscript interpreter can be set here.

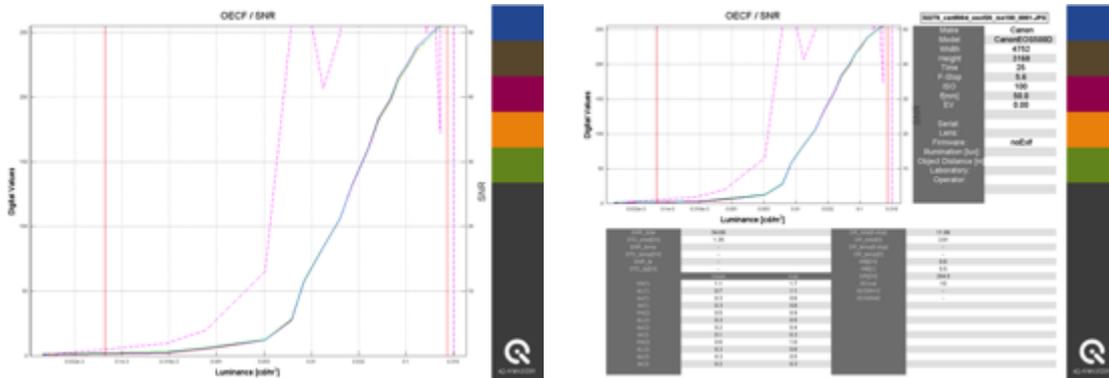


Figure 9 Report without (left) and with numerical results and meta data (right)

### Export Folder

Selection of the folder in which numerical and graphical results are stored:

- Same as File(s):* figures are exported into the same folder as the original image files
- Select each time:* the export folder will be selected for each image analysis
- Selected Folder:* selection of a standard export folder

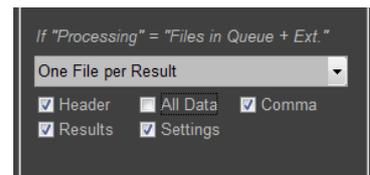
### Save binary files to TIFF (.tif)

For the analysis of bistream files the file is first converted into a TIFF image. Activate this function to store this TIFF file.

### If “Processing” = “Files in Queue + Ext.” ...

In every module you can choose which files will be analyzed. When „Files in Queue + Ext.“ is selected you can define if the results will be stored separate files or in one file:

- One File per Result:* for every image one file with numerical results is created
- Multiple Results in one File:* creates one file with the results of all images



output properties

Define which information is stored to the result file:

- Header:* Information about evaluation software version, file name, file data, EXIF data
- Results:* Only relevant results
- All Data:* All measured values
- Settings:* Settings information

*Comma:* If enabled, the text output is given with a decimal comma instead of a point, which can make the import to MS Excel much easier



### If Result-File exists ...

If a file is already analyzed there are different options how to deal with the existing result files:

- Add Index to ResultFile:* New results are saved in a new file with an index (e.g. „oecf“, „oecf1“, „oecf2“)
- Overwrite:* The old results are replaced by the new ones
- Ask for new Name:* If the result file exists the user will be asked for a new file name

### Text Output

Define the format of the result file:

- TXT-file:* All numerical results and data according to text output selection will be stored in an text file
- XML-file:* All numerical results and data according to text output selection will be stored in an XML file (note: XML export is not available for UTT Module )
- TXT & XML-file:* All numerical results and data according to text output selection will be stored as text and as XML file (note: XML export is not available for UTT Module)

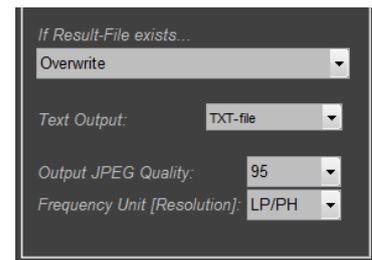
### Output JPEG Quality

Define the quality of the exported JPEGs like check images (percentual scale, 100% corresponds to best quality)

### Frequency Unit [Resolution]

Select the unit of spatial frequency that is used in the output of the resolution module:

- LP/PH:* linepairs per picture height
- LP/Pix:* linepairs per pixel
- PPI:* pixel per inch
- LW/PH:* line width per picture height



output settings



## 5.5.2. Filepaths & Filehandling

In this menu you can change the default location for chart layout and other files.

### Chart Layout Location

Reference data of the chart layout. The local folder „Chart“ is set as default.

### OECF Reference Data Location

OECF reference data. The local folder „Data“ is set as default.

### Color Reference Data Location

Color reference data. The local folder „Data“ is set as default.

### Viewing Condition File Location

Reference data of the viewing condition file. The local folder „Data“ is set as default.

### Initial Setting File Location

Folder location of the settings file `.myset` that you can choose in „Restore settings from this file“.

### Maximum Files in Memory

Defines the maximum number of image files that will be kept in memory. A reasonable value depends on the available storage of your computer system. A common value is 10. If you have huge files select a smaller value.



### Default PPI resolution

Mainly used for scanners. If no EXIF data exists, this value is used in the *Resolution* module. A warning appears after calculation if no EXIF data is available.



general settings



### Extension definition if not numerical

Working with extensions is intended for processing image sequences. If your extensions are not numerical you can specify them here.

Example: You captured three pictures named „shading\_w.jpg“, „shading\_s.jpg“ and „shading\_t.jpg“. Define the extension „W“ (wide), „S“ (standard) and „T“ (tele) in this text field. The extensions have to be divided by a space.



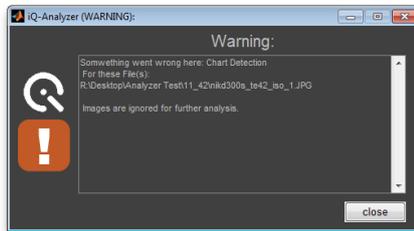
define extension if not numerical



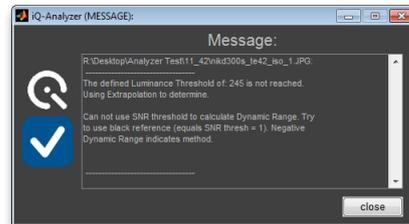
### 5.5.3. General

#### Hide Warnings, show Errors only!

iQ-Analyzer displays errors (marked in red) and warnings (marked in yellow).



displayed error

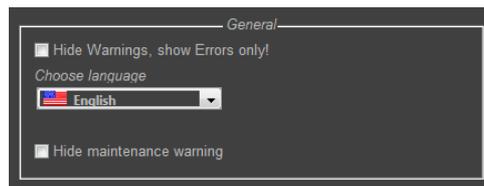


displayed warning

The warnings (e.g. if the exposure is not saturated) can be deactivated by selecting the checkbox. This can be helpful for users who want to analyze images with unusual settings.

#### Choose language

Available languages are English, Chinese and Japanese.



General

#### Hide maintenance warning

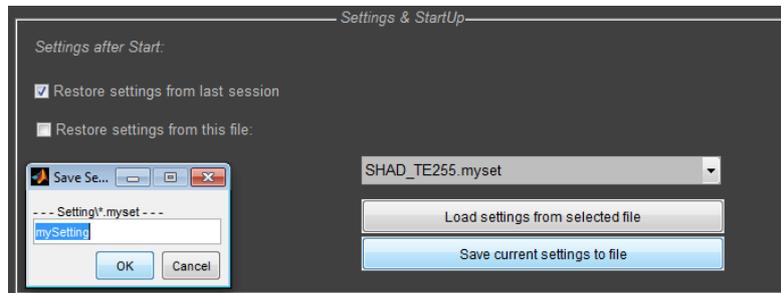
Disables the warning announcing the expiry of the iQ-Analyzer Maintenance. For extending the maintenance program please contact [sales@image-engineering.de](mailto:sales@image-engineering.de)



## 5.5.4. Settings & StartUp

### Restore settings from last session

The current settings will be used when a new session is started.



Settings & StartUp

### Restore settings from this file

The selected file from the dropdown menu is used when a new session is started.

### Load settings from selected file

Choose a *.myset* file from the dropdown menu and load the settings by using this button.

### Save current settings to file

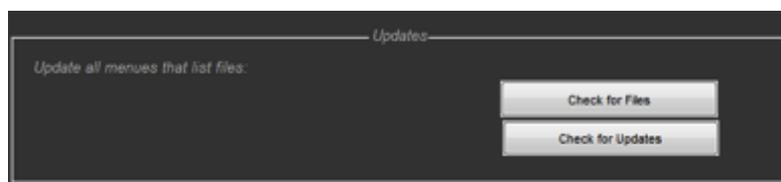
Saving current settings with an individual name.

Note: For using the *.myset* files in the iQ-Analyzer *Home* section, the filename must not begin with numbers. Please name *.myset* files beginning with letters.

## 5.5.5. Updates

### Check for files

All menus that contain data files (*.chart*, *.den*, *.lum*, *.myset* etc.) are reloaded. It is useful if you have added data or have changed paths in the section Filepaths & Filehandling.



### Check for updates

This button links you to the iQ-Analyzer information on the Image Engineering website. Here you can check if you are using the most actual version of the iQ-Analyzer. Compare the version number of the



offered iQ-Analyzer on our website with the version information at the top of the iQ-Analyzer window. For security reasons we do not communicate directly with any server.

### 5.5.6. Internal Calculations

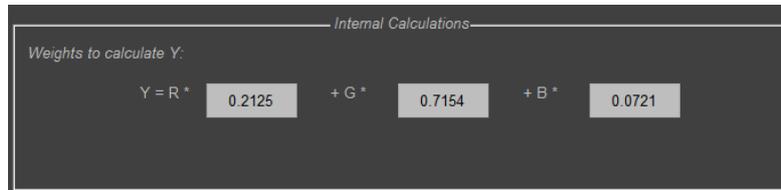


Figure 10 Default values to calculate Y

### Weights to calculate Y

iQ-Analyzer uses the constants defined by the profile to calculate the luminance Y. If no profile is defined these weights will be applied to calculate Y. Weights of common standards are:

ITU-R BT.709 (recommended)	$Y = 0.2126 R + 0.7152 G + 0.0722 B$
ISO 12232	$Y = 0.2125 R + 0.7154 G + 0.0721 B$
NTSC	$Y = 0.2989 R + 0.5870 G + 0.1140 B$

### 5.5.7. Home

#### Manage Home

Using this button a menu opens in which you can manage layouts and settings that will be available in the iQ-Analyzer *Home* section. The modifications do not delete or change any data files. They only affect the visibility of chart layouts and settings in the *Home* screen.



Figure 11 Enter the manage home menu

#### Step 1: Choose module

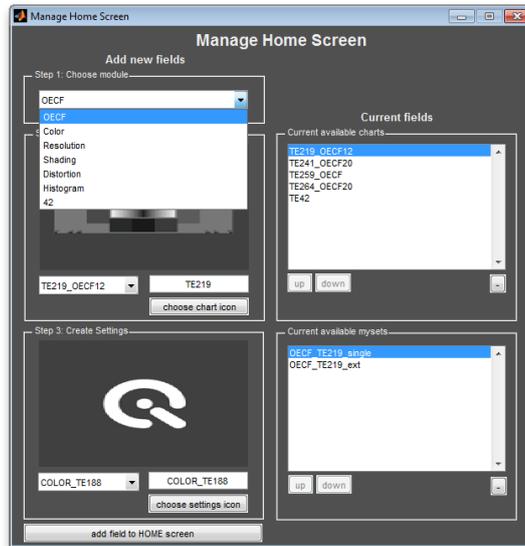
First make selection of the module you want to make modifications for.

#### Step 2: Choose chart

On the right side all charts are listed which are already inserted in this module and displayed in the *Home* screen. On the left there is a drop down menu which contains all chart layout files which are stored in the chart layout folder. To add a further chart layout to the list, select the chart out of the



dropdown menu. The layout display name could be edited to your purposes (optional). This will not change the file name! You can also choose an icon for this layout (optional).



### Step 3: Create Settings

The next step is assigning the settings you want to apply to the chosen chart. Select the setting from the drop down menu, edit the display name of the settings (optional) and select an icon (optional).

### Add field to HOME screen

At last press this button and the chart layout with the setting appears in the iQ-Analyzer *Home* section. To add further settings to a chart layout select the chart layout do the adjustments of step 3 and click again at „add field to HOME screen“ to complete the conjunction.

To delete a setting or a chart layout select it in the list and delete it by clicking on the minus symbol on the bottom right.

Note: For using the .myset files in the *Home* screen the filename must not begin with numbers. Please name .myset files beginning with letters, for example: TE253\_2014.myset.

## 5.5.8. Viewing Conditions

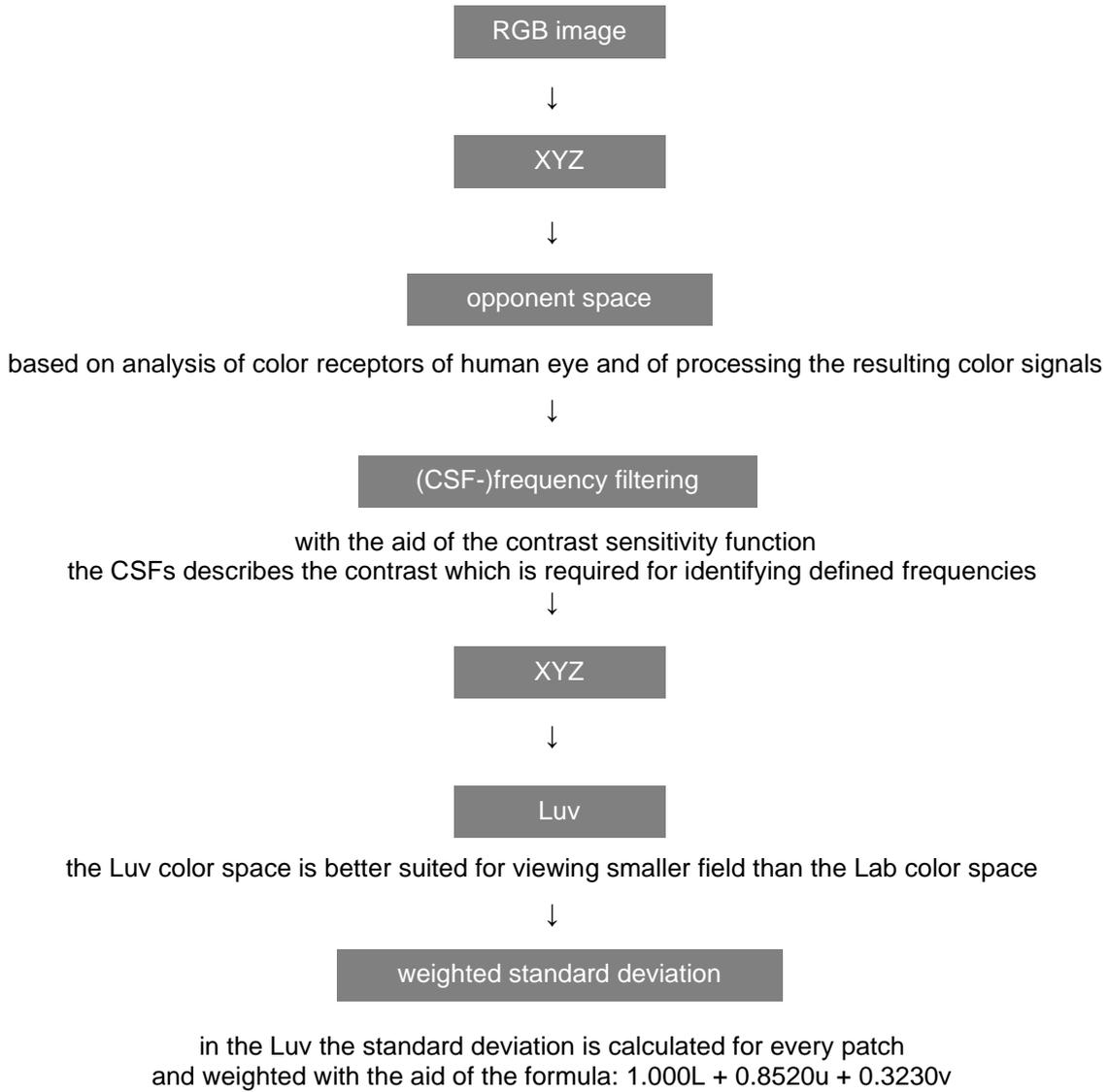
Unlike the ISO 15739 camera signal-to-noise ratio the visual noise is evaluated as an output referred noise. Visual noise takes into account that the spatial distribution of noise could be different and considers that human observers react different on color and/or intensity noise. Visual noise quantifies how well a human observer can recognize the noise in the analyzed image.

The iQ-Analyzer is capable to calculate the „Visual Noise“ metric since Version 3.



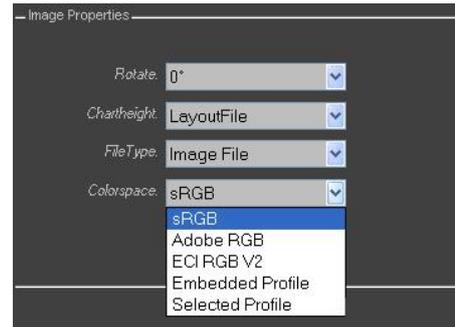
At the time of first implementation, the algorithm was an informative appendix to the ISO 15739 standard. With the development of the version ISO15739:2013, making the visual noise approach normative, Image Engineering actively worked together with the workgroup at ISO to get a reference implementation.

With the aid of six transformation steps the visual noise of RGB images can be calculated.





The flow chart above shows that for calculation of visual noise the RGB image data has to be converted into the CIE XYZ space as one of several steps. The colorspace of the input can be specified in the Meta data under image properties (see on the right).



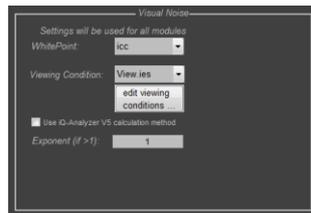
specify the colorspace in the Meta data

The specifications in the visual noise settings refer to different modules: OECF, Color and Shading

### White point

Specify the white point that should be used to calculate the visual noise.

- icc:** Use the icc standard white point (D50). The color management specified by the ICC is based on this white point.
- Profile:** Use the white point specified in the profile header (illuminant).

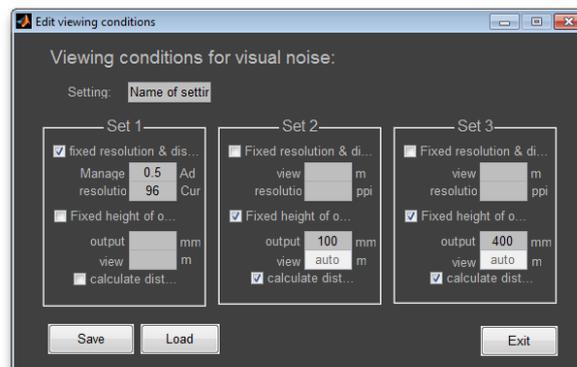


White point and viewing conditions setting

### Edit viewing conditions

As the visual perception of noise depends on the viewing conditions, you have to specify them. Select an *.ies* file for the visual noise calculation from the dropdown menu.

The „*edit viewing conditions*“-button opens the adjustment for the viewing conditions. To edit and/or create your own *.ies* files, load one *.ies* file by pressing the „*Load*“-button and change the default values. Name your setting and press the „*Save*“-button. „*Exit*“ closes the window.



Edit the viewing conditions



The *.ies* files are stored in the folder you selected in the settings. The default folder is :

C:\ProgramData\Image Engineering\iQ-Analyzer V6.X.X\Data

The default *view.ies* contains three settings:

- Set 1:* 100% view on a monitor, 0.5 m viewing distance, 96 ppi monitor resolution
- Set 2:* Print with 10 cm height, calculate viewing distance auto
- Set 3:* Print with 40 cm height, calculate viewing distance auto

Both prints are supposed to be observed at a viewing distance of the diagonal of the print (auto). The minimum viewing distance is 25 cm.

### **Use iQ-Analyzer V5 calculation method**

The default calculation of the iQ-Analyzer Version 6 is according to the reference implementation of the ISO15739:2013 standard. This implementation has slight differences to the implementation in previous versions of the iQ-Analyzer. Enabling the old calculation method should only be used for comparison reasons. We recommend to switch to the implementation from Version 6 as soon as possible

For details review the Technote “Visual noise – the differences in implementation”:

<http://www.image-engineering.de/library-m/technotes/707-visual-noise-the-differences-in-implementation>

Note: This option will be no more available in future versions of the iQ-Analyzer.

### **Exponent (if > 1)**

The results of the visual noise calculation can be spread out. Specify an exponent. We recommend an exponent = 1 to get the original results.



## 6 ANALYZING PROCESS AND RESULTS

### 6.1. ANALYZING PROCESS

If you are finished with the setup up you can press the „Start“ button and the analyzing process will begin. In the upper frame you see the progress bar. The numeric results and an image with marked ROIs are saved automatically as text and JPEG files depending on your export settings. Using the „Stop“-button aborts the analyzing process.



progress bar and stop button

Depending on the amount of images the calculation time extends. If a file could not be analyzed, the calculation process will go on with the next file in the list. Each file in the file list is preceded by an icon which shows the status: a gray dash informs you that the file is not processed yet, a green check marks a file which analysis is completed and a red cross shows that an analysis has failed.

During analyzing process warnings might be displayed if not disabled in the settings. The warnings give you information about uncommon image properties and might be a hint that an image was not captured properly. However, warnings might also appear due to camera quality.

### 6.2. RESULTS

#### 6.2.1. Graphical presentation

##### Image/Result

This toggle button switches between the Result and Image View. Als long as the measurement has not been processed, this toggle button switches between the empty results window and the input image. After calculation the result view shows the graphical representations and the image view different check images to review the process.



„Image“ and „Result“ button

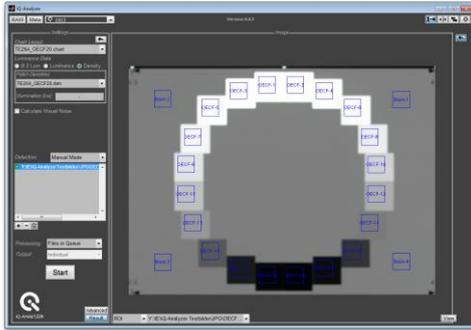
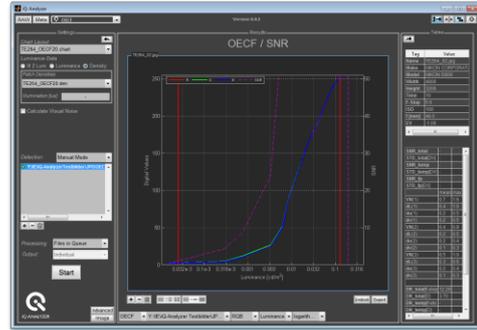


Image View



Result View

## IMAGE VIEW

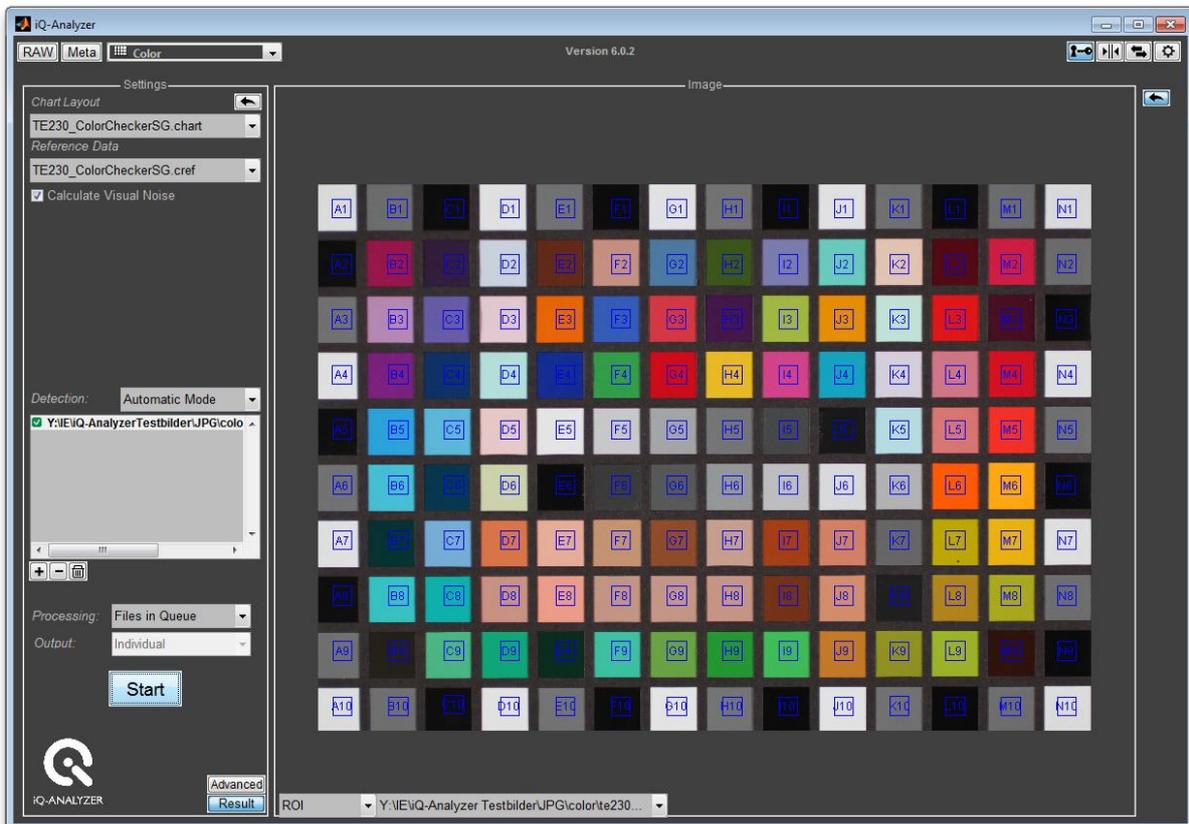
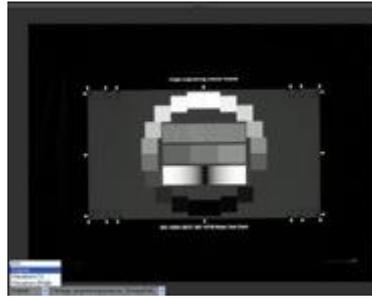


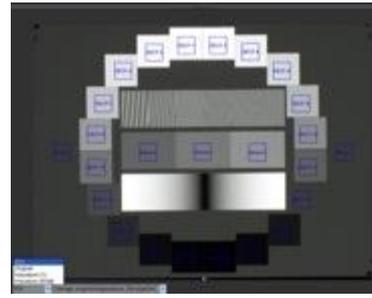
Image View

The *Image View* provides several representations of the original image. Below the graphical presentation are two dropdown menus. The left one allows switching between the check, ROI and the input image. The right one shows the path to the original image.

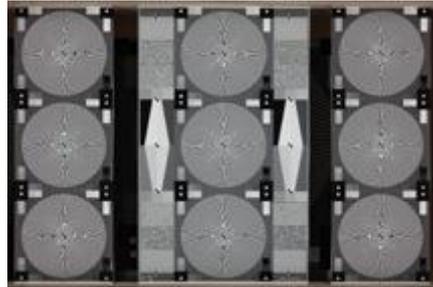
**ROI:** The ROI image is the overlay of all ROIs on the original image. If you have doubts that the detection is correct, this facilitates you to have a quick check.



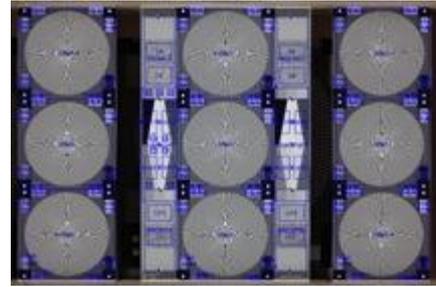
Original image / OECF module



ROI image / OECF module

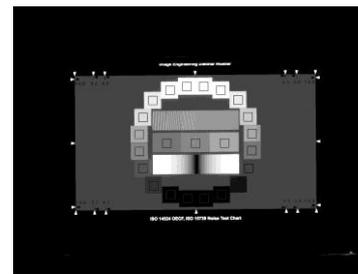


Original image / resolution module



ROI image / resolution module

An image named with the extension „filename\_check.jpg“ is saved automatically. In this image the ROIs are marked. The folder for saving and image quality can be defined in the settings.



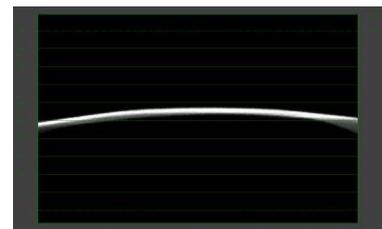
filename\_check.jpg

*Original:*

Displays the original image.

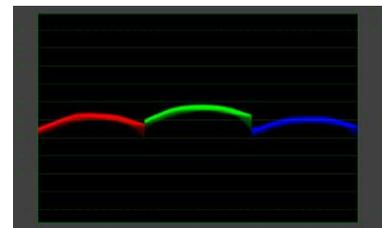
*Waveform (Y):*

The waveform visualizes the distribution of luminance values (Y) of the image. The image is read line by line (x-axis) and the luminance values are outlined as percentual (y-axis left) or digital values (y-axis right). The brighter the graph the bigger is the number of the luminance values.



*Waveform (RGB):*

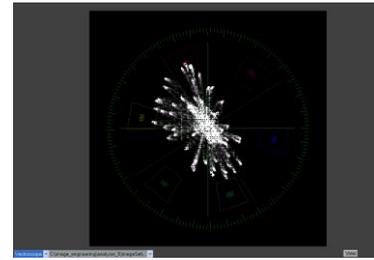
The RGB waveform displays the distribution for R, G and B values.



Waveform (RGB) / shading module

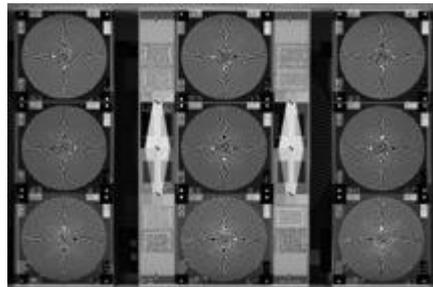


**Vectorscope:** The color vectors are visualized in a circular scale. The higher the color saturation the further away from the center is the shown chromaticity coordinate. Achromatic tones will be shown as points in the center.

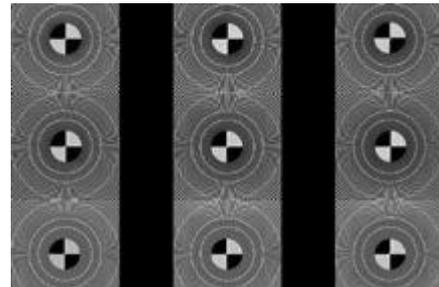


Vectorscope / color module

**CheckImage:** Representation in which the analyzed regions are marked in gray. The CheckImage named „filename\_check.jpg“ is saved automatically.



CheckImage / resolution module



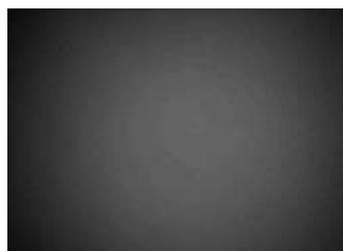
CenterImage / resolution module

**CenterImage:** The star from center to a defined percentage of the Nyquist frequency is shown (see advanced settings for SFR Siemens). The inner circle shows the Nyquist frequency. The other two circles show 75% and 50% of the Nyquist frequency. The CenterImage named „filename\_center.jpg“ is saved automatically.

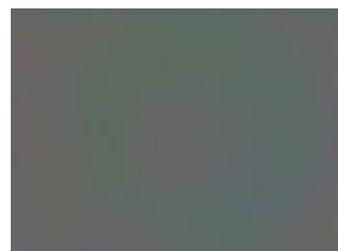
**LumBoost:** This view is available in the shading module. During the analyzing process the image is converted to the LCh colorspace. The luminance distribution is shown depending on your defined boost (advanced menu, default = 1x).



original image / shading module



LumBoost image / shading module



SatBoost image / shading module



**SatBoost:** In the shading module this representation shows the saturation distribution depending on the defined boost (advanced menu, default = 1x).  
The SatBoost, named „filename\_satboost.jpg“ is saved automatically. Path for saving and image quality/type can be defined in the settings.

Note: The CheckImage, CenterImage, LumBoost and SatBoost image are saved automatically. Path for saving and image quality/type can be defined in the settings.

Note: The UTT module offers some other graphical representations. They are described in chapter 8.12 UTT.

The dropdown menu next to the *Image View* contains the particular image files if „Files in Queue + Ext.“ is selected in the output processing below the file list on the left side. The average result of all files is also listed here if it has been selected („Average“ or „Average + Individual“). By using the dropdown menu you can switch between the results of the image files of the sequence and the average result.

### View

By pressing the „View“-button in the lower right corner of the *Image View* the image will show in a new window and enables viewing the file content in more detail. This representation is used for visual analysis and should be set to 100%.



„View“-button

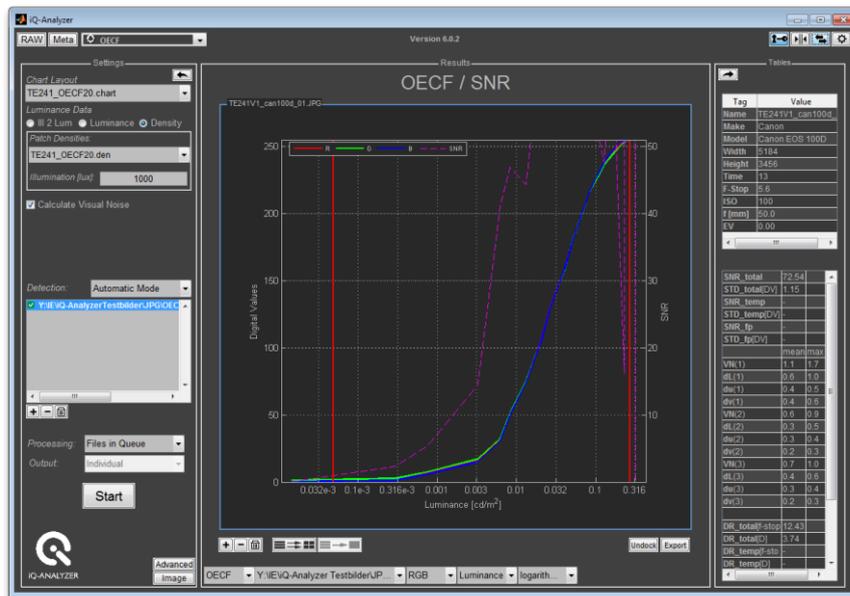


editing window and the image in a new window

The preview is also accessible by double clicking on a file name in the file list.



## RESULT VIEW

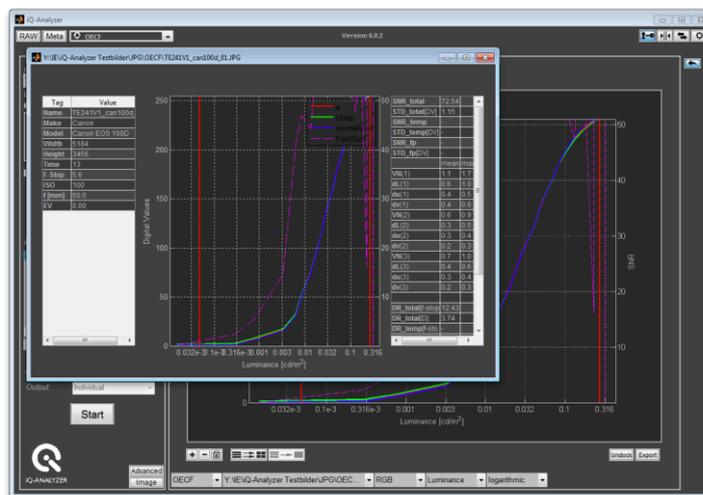
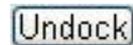


Result View

By pressing the „Result“-button, the numerical results are displayed in the right screen using different diagrams. The *Result View* provides, depending on the module, dropdown menus to select a graphical presentation. For a detailed description of the options refer to the section of the module in this manual. Depending on the graphical presentation you might find some buttons in the bottom right corner of the results view, which enable you to do further adjustments:

### Undock

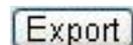
The graphical result is displayed in a new window. You can undock multiple graphs from different modules or the same module.



undocked window

### Export

You can export the actual graph to the folder, which is defined in the „Settings“ menu. The file format you can also set in the „Settings“ menu.





### Pan

This functions enables you to pan the graph horizontally and vertically. Click on the „Pan“ button and adjust the graph with the mouse pointer. This might be interesting in combination with the zooming function.

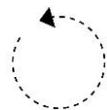


### Zoom

You can zoom in and out by clicking on the graph with the left (zoom in) or the right (zoom out) mouse button.

### Rotate

Enable „Rotate“ and the cursor shows a small circle when it is over the graph. Clicking and moving the mouse rotates the graph.



Cursor

### Reset

Clicking on the „Reset“-button will reset to default view.

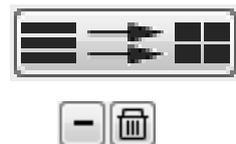
## 6.2.2. Multiview display

The iQ-Analyzer Version 6 provides a great new option to display the results. Up to four results of one or different modules can be displayed side by side. For some values there is also an option available that arranges multiple results of one module all together in one diagram.

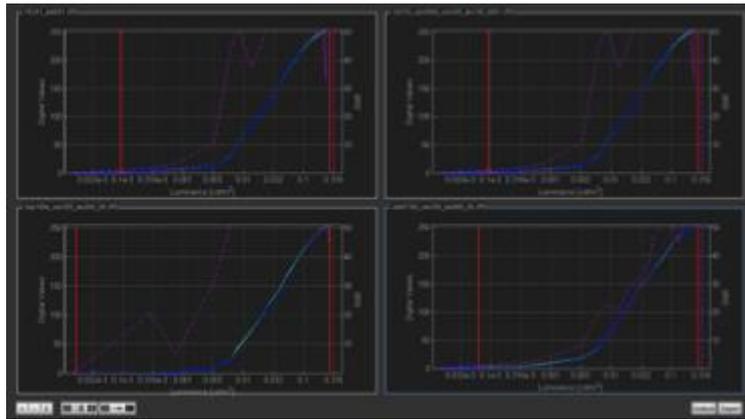
This function provides a comprehensive overview, for example, about all tests that are done with one camera or a comparative overview of different cameras.

### SHOW RESULTS FROM CURRENT FILE LIST IN SEPARATE GRAPHS

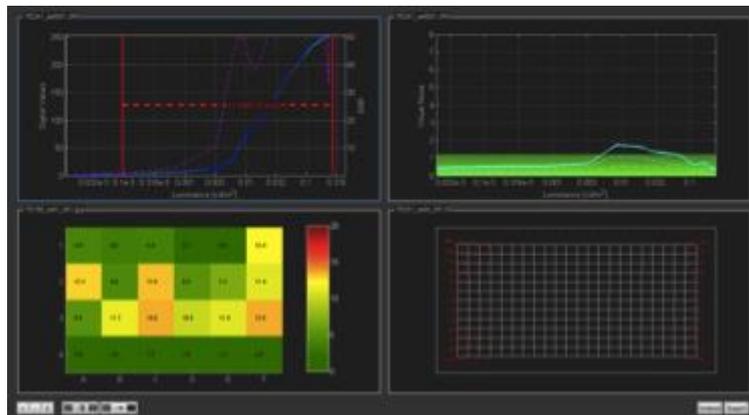
This function will show the results in separate graphs. It can open up to four graphs automatically, one for each file in the file list. The title of each graph contains the file name. The view can be changed by using the dropdown menus in the results view. A change will be applied to all graphs.



Deactivate the *multiview display* by clicking again on the button. Mark one graph by clicking on it. The frame of the box changes to blue. Use the „-“ button to delete this graph or use the „trash“ button to delete all graphs.



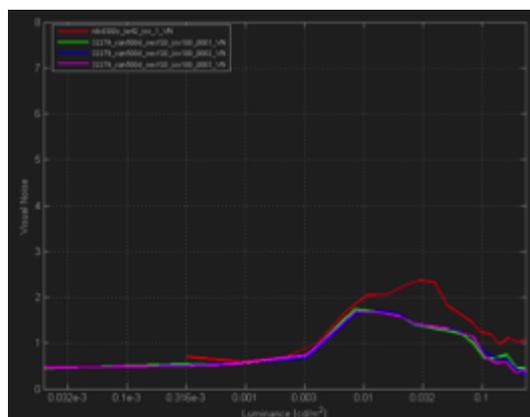
You can also display graphs of different modules next to each other. Use the „+“ button to open up to four graphs. Select a graph by clicking on it and then choose a module file and view. Repeat this for the other graphs.



Note: The multiview option (separate graphs or combined in one graph) must be deactivated.

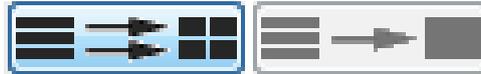
### SHOW RESULTS FROM CURRENT FILE LIST COMBINED IN ONE GRAPH (IF POSSIBLE)

The second option merges multiple results of the listed image files in one graph.





This option is not available for all views. The button is deactivated when not available.



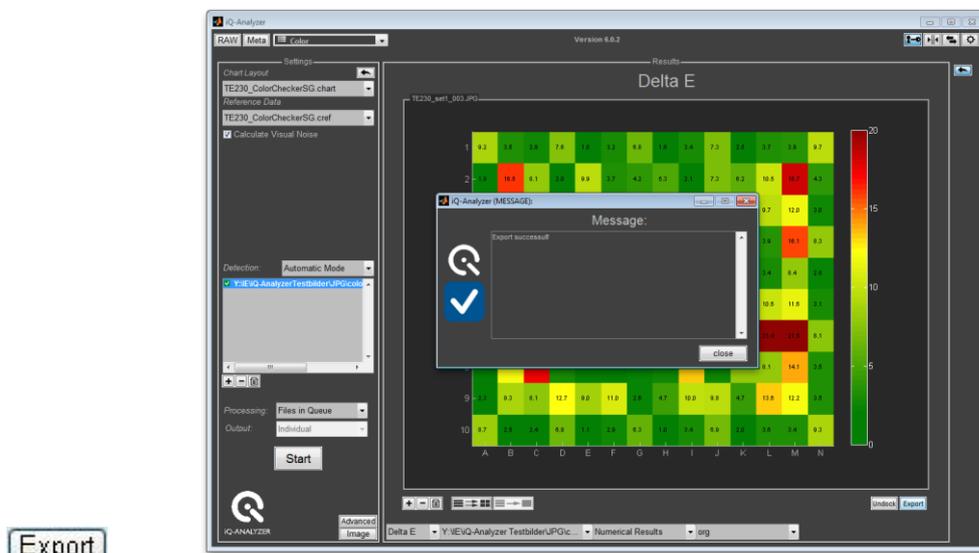
### Views with enabled combined view option:

- OEFC:** Visual Noise  
Noise
- Resolution:** Siemens/MTF Stars  
Groups
- Shading:** all plots
- Distortion:** vs field  
Chromatic aberration – GR vs image height  
Chromatic aberration – GB vs image height

## 6.2.3. Export graphical results

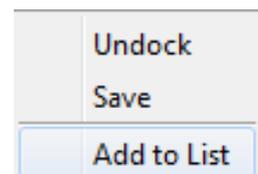
### Export

You can export a single graph using the export button. The file format is defined in the *General Settings*.



### Add to list

With a right click at the graph you can choose „Add to list“. The actual view is now added to a list which can be exported afterwards. Examine and export the complete list in the *Import/Export* menu (see chapter *Import/Export*).





### 6.2.4. Numerical results

On the right side of the graphs the result tables can be displayed. They include the EXIF data of the selected image and the numeric results.



#### EXIF (exchangeable image file format) data

This table is equal in each module. It shows the EXIF data which is contained in the image file. The EXIF data is also listed in the *Meta* menu.

Tag	Value
Name	32279_can500d_oe.
Make	NIKON CORPORATI.
Model	NIKON D7000
X-Dim	4928
Y-Dim	3264
Time	60
F-Stop	2.8
ISO	100
f [mm]	120.0
EV	45.0048.0046.0051..

#### Numerical Results

The second table contains all module specific results. It changes depending on the module. A detailed description of the specific results is contained in the description of each module.

SNR_total	54.48	
STD_total[DV]	1.36	
SNR_temp	-	
STD_temp[DV]	-	
SNR_fm		

### 6.2.5. Export numerical results

There are different options to export the results of the iQ-Analyzer. Adjustments of format and target folder can be set in the *General Settings (Output and PDF Export)*.

#### .txt/XML

You can export .xml and .txt files. XML files generated by the command line interface are available since version 6.1.7.

#### .ps/.pdf

Use this option to create a readymade report including graphs or related data .

#### copy & paste (tables)

Single or multiple cells of the tables can be copied and pasted to any other document. Fast exchange or discussion is possible using this feature without dealing with the output files.



## 7 VIDEO

The video functions of the iQ-Analyzer are designed to link video sources to the evaluation core. Live video signals and video files can be processed.

### 7.1. VIDEO MODULE

The Video Module introduces convenient acquisition of frames and passing them to any other iQ-Analyzer Module for deep analysis. For live video signals measurement tools are available such as waveform monitor, vectorscope and histogram display. Furthermore, the versatile live analysis of color distance and creating own device-specific color reference datasets can easily be accomplished.



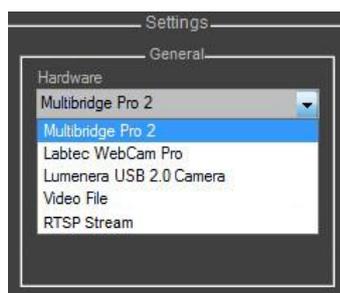
“Video” tab

**Note:** For analyzing video files it is necessary that the proper version of the VLC player is installed. iQ-Analyzer is distributed with a Windows installer of VLC Player. Please make sure the ActiveX plugin is installed.

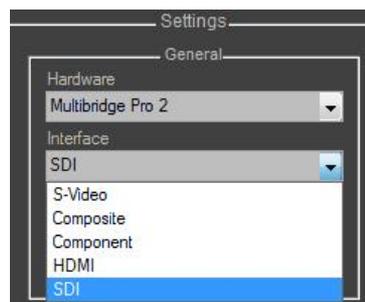
#### 7.1.1. Settings for live video sources (except RTSP streams)

##### General

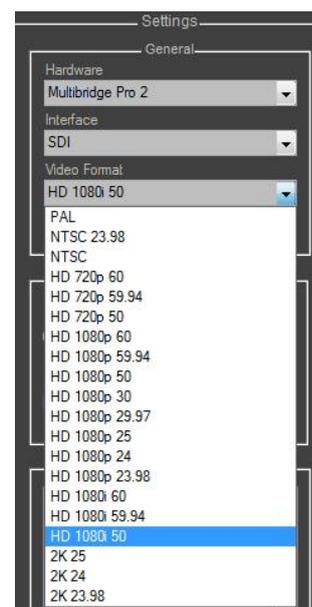
In this section of the settings panel you can select the connected video input hardware, used interface and video format. Please note that the selection of the interface and video format are device dependent. For video file sources please select „Video File“ in the Hardware dropdown menu and refer to the section 7.1.3 of this documentation.



Settings – Hardware



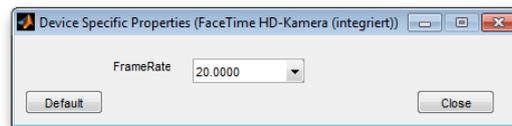
Settings – Interface



Settings – Video Format



## Device Specific Properties



device specific properties

If the driver of your video input device (e.g. framegrabber or web-camera) provides more detailed adjustments such as gain, frame rate or sharpness, you can set them in the „*Device Specific Properties*“ window. If no options are available, the button will be inactive. Please note that these settings are device and driver dependent.

## Trigger

In order to analyze the video data using the iQ-Analyzer modules, a number of frames has to be acquired. The trigger section provides control over the acquisition.

*Capture every:* Defines which frames should be captured. Select 1 to acquire every frame, 2 for every second frame etc.

*Frames per trigger:* Defines the number of frames to be captured on the next acquisition triggered by the „*Capture*“ button.



settings for number of

The „Trigger“ menu for video files differ also slightly from live video streams. Please refer to section 1.2 of this chapter.

## Capture

Pressing the „*Capture*“ button triggers an acquisition. A number of frames, as defined by the Trigger/Trigger Batch settings, is captured and shown in the file list. These files are automatically saved. Folder, file format and file name prefix can be defined in the „*Advanced*“ menu.

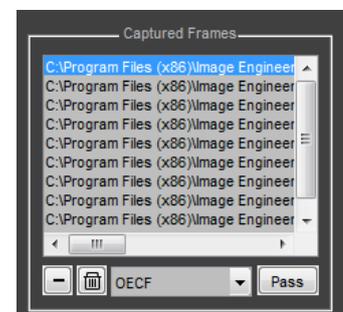
## Captured Frames

The list contains all frames captured as defined in the trigger menu.

You can delete selected frames from the list using the „-“ button or clear the entire list pressing the „C“ button. The saved image files will not be removed.

Select one or more frames by using „*ctrl*“ and mouse click.

Choose an iQ-Analyzer module in the dropdown menu and press the „*Pass*“ button to pass the frames to the module for an extensive analysis.



## Preview, Measurement and Comparison

See section 7.1.5 Preview, Measurement and Comparison mode.



### 7.1.2. Settings for RTSP compliant live streams

#### General

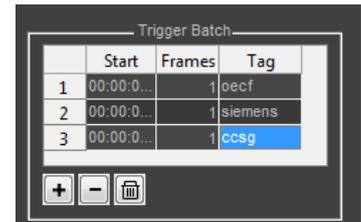
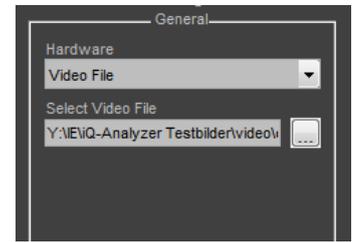
Select „RTSP Stream“ in the Hardware dropdown menu. Insert IP address and press „Connect“.

#### Trigger Batch

A trigger defines the start position in the video file for capturing the defined number of on the next acquisition triggered by the „Capture“-button.

You can create multiple triggers for a single video file. Please navigate to the desired position in the video file using the timeline slider and press the „+“ button. You can also press this button when playing the video. Selecting a trigger in the table will navigate to its position in the video file.

You can delete triggers from the table using the „-“ -button or clear the entire table using the „C“-button.



### 7.1.3. Settings for video files

#### General

Select „Video File“ in the Hardware dropdown menu. The selection of the video file is accomplished in the edit field below.

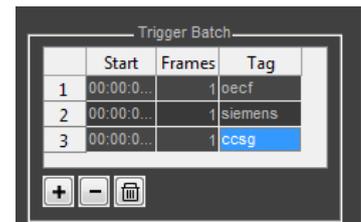
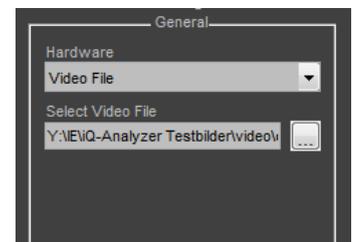
#### Trigger Batch

A trigger defines the start position in the video file for capturing the defined number of frames in the next acquisition triggered by the „Capture“-button.

You can create multiple triggers for a single video file. Please navigate to the desired position in the video file using the timeline slider and press the „+“ button. You can also press this button when playing the video. Selecting a trigger in the table will navigate to its position in the video file.

You can delete triggers from the table using the „-“ -button or clear the entire table using the „trashcan“-button.

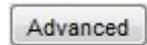
The amount of frames to be captured can be edited in the trigger batch table for every single trigger. You can also set a specific tag for every trigger in this table. This tag is added to the file name of the acquired frames in order to easily handle multiple acquisitions.





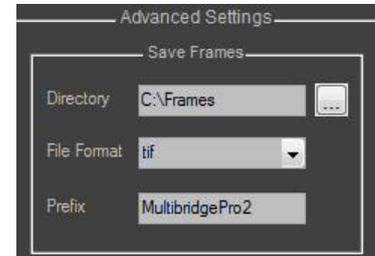
### 7.1.4. Advanced Settings (live video sources and video files)

The Advanced Settings panel is activated using the „Advanced“ button on the bottom of the Settings panel.



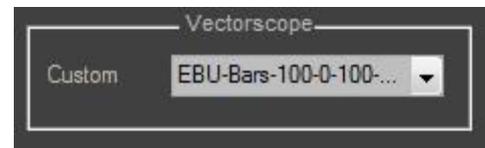
#### Save Frames

A number of frames, as defined by the Trigger/Trigger Batch settings, is saved as files. Define folder, file format and file name prefix.



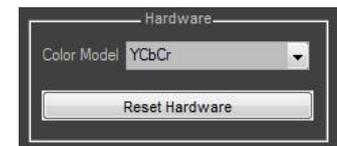
#### Vectorscope/Custom

Custom layout files for the vectorscopes graticule containing the positions of the target fields can be selected here. Custom files are provided on request.



#### Hardware

Choose the color model that is used for the representation of the video signal (RGB, YCbCr or grayscale).



Press the „Reset Hardware“ button if you have connected or detached a hardware device. The search for the available devices is performed without the necessity to restart the iQ-Analyzer.

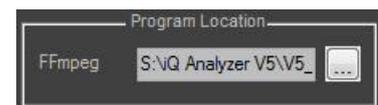
#### Warning Level

Define the warning levels for the visualization of the color differences in the „Comparison“ Mode. Setting Delta E warning level to 20, for example, will mark the color patches in your test target red if they are Delta E equal or greater than 20. The patches with Delta E smaller than 20 will be marked in the shades of yellow and green, depending on their Delta E.



#### Program Location

The iQ-Analyzer is distributed with an automated FFmpeg 32-bit Windows build in order to extract frames out of a video file. It is located in the 3rdParty folder. If you want to use another version of FFmpeg, you can select its program location using the „...“ button.





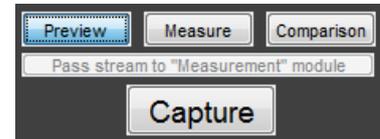
## Color Comparison

Selection if detecting the color patches in the comparison mode should work automated or manual. For details please see in chapter 7.1.5.

### 7.1.5. Preview, Measurement and Comparison mode

Selecting one of the modes will change the view in the preview window.

Please note that the measure and comparison modes are only available for live video sources. You can switch between the modes using the toggle buttons „Preview“, „Measure“ and „Comparison“.



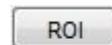
## PREVIEW

The preview window shows the actual video and allows a visual evaluation.

*Live video:* For the live video sources it helps you to easily set up your environment and adjust your camera's position and the scene lighting. The field of view can be limited.

## ROI

The ROI (region of interest) of the video can be selected. Press the „ROI“ button in the bottom left corner. Select the ROI by adjusting the rectangle in the display. Press the „Confirm“ button to crop the image. To see the full image again, press the „Full“ button.



Preview



initial ROI

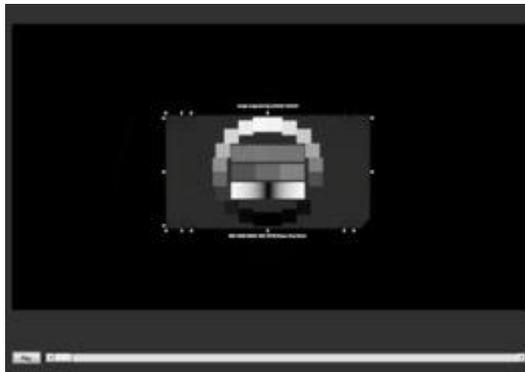


adjusted ROI



confirmed ROI

*Video files:* You can navigate through the video file using the timeline slider or play and pause the video by using the „*Play/Pause*“ toggle button.





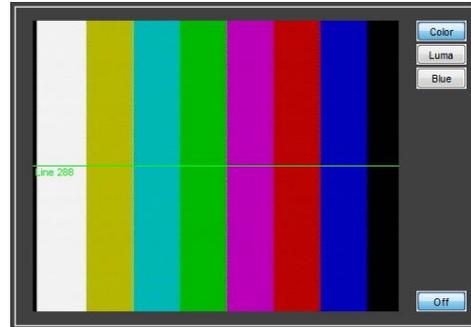
## MEASURE (LIVE VIDEO SOURCES ONLY, EXCEPT RTSP STREAMS)

Measurement instruments, such as histogram display, waveform monitor and vectorscope, provide a quick overview.

### Preview Display

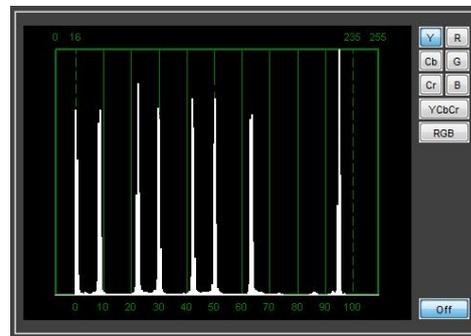
Select a single video line to be analyzed by clicking into the display on the preview panel. Choose between Color, Luma and Blue view.

The preview display can be switched off if not used. This can improve the performance of the other displays.



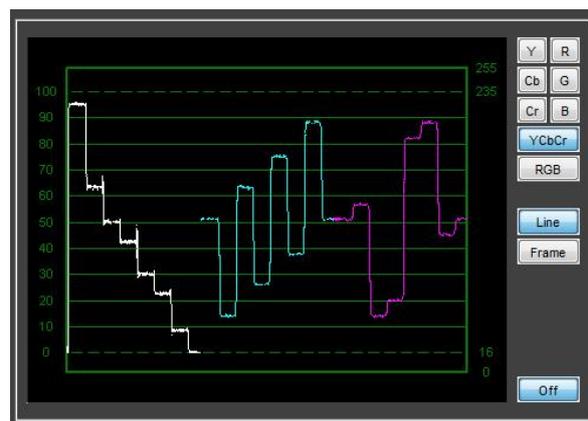
### Histogram Display

The histogram can be displayed for the luma signal Y, the color difference signals Cb, Cr and the color signals R, G and B. The upper horizontal axis shows digital values (0 – 255). Digital video signals range from 16 to 235 (indicated with the dotted line). Values between 0 and 16 and 235 and 255 are reserved for the foot- and the headroom. The lower horizontal axis displays the digital values 16 – 235 as percentage. The histogram display can be switched off if not used which will improve the performance of the other displays.



### Waveform Monitor

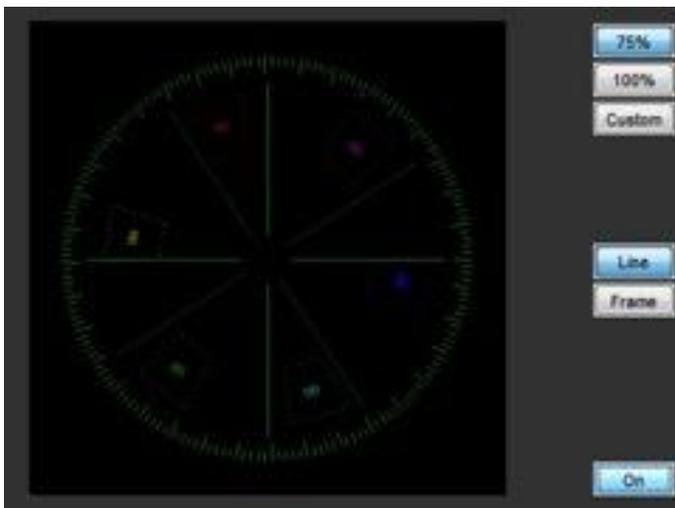
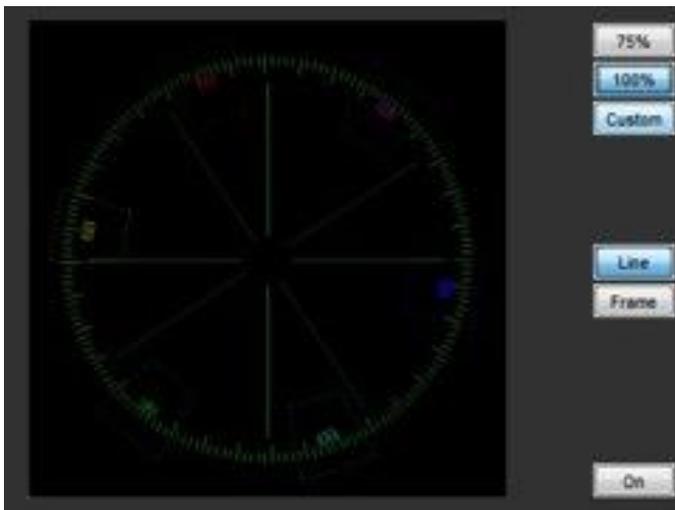
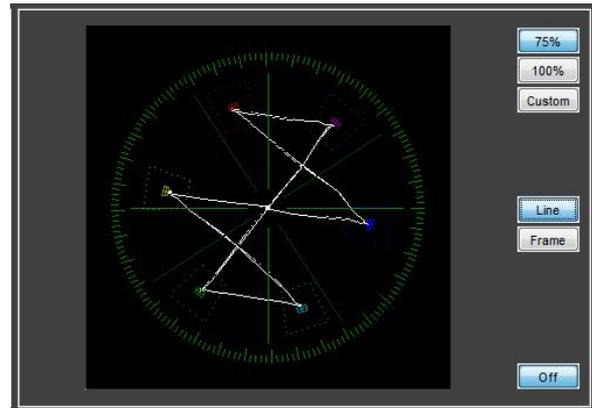
The video signal can be visualized for one line or the entire frame. This can be performed for the luminance signal Y, the color difference signals Cb, Cr and the color signals R, G and B as single channel or parade view. You can also toggle between single line and full frame display. The right vertical axis shows digital values (0 – 255). The left vertical axis displays the digital values 16 – 235 as percentage. The waveform monitor can be switched off if not used. This will improve the performance of the other displays.





## Vectorscope

The vectorscope graticule can be set up for 75% or 100% (referred to as EBU Color Bars). If you have a custom graticule layout file, you can select it in the Advanced Settings and use it by the “Custom” toggle button. You can switch between single line and full frame display. The vectorscope can be switched off if not used. This will improve the performance of the other displays.



Vectorscope set up for 100% and 75%

## COMPARISON (LIVE VIDEO SOURCES ONLY, EXCEPT RTSP STREAMS)

The comparison module allows a fast and easy color evaluation of live video signals. The human eye is a very sensitive instrument for color comparison, especially for a side by side comparison. Numerical



evaluation of color distance can also be performed. For more extensive numerical evaluation based on ISO and CIE standards just capture some frames and pass them on to the iQ-Analyzer's Color Module.

### Chart layout

First define the chart layout from the dropdown menu.

### Reference

Select the according reference file from the second dropdown menu.

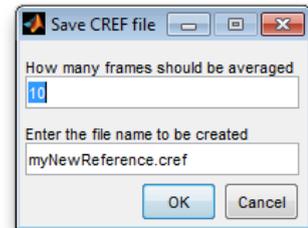
### Detect

Press „Detect“ and the blue ROIs will appear at each color patch.



### Create CREF

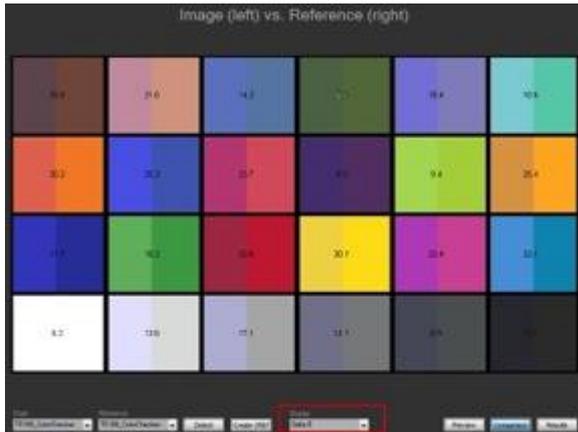
The color data from the video stream can be saved and used as a reference file for other devices, e.g. for matching cameras in a studio environment. Open the creation dialog pressing the „Create CREF“ button. The saved reference file will appear in the „Reference“ dropdown menu. Press „Detect“ button again in order to use it.



### Preview/Comparison/Results

For visual comparison (Image vs. Reference) press the „Comparison“ button. For numerical results press the „Results“ button.

- Preview:* Shows the actual video with marked ROIs
- Comparison:* Displays a visual comparison between the actual color patch and the reference color patch. The dropdown menu „Display“ allows changing the representation for the color difference:
  - Delta E: color distance
  - Delta L\*: lightness distance
  - C\*: chroma/saturation
  - Delta h\*: hue
  - none: turns off the numerical results in the visual comparison mode
- Results:* Displays the numerical results with warning levels which are set in the advanced settings of the video module. The drop down menu „Display“ offers the same options like for comparison except „none“.



Visual comparison with and without numerical results



numerical results

### 7.1.6. Pass stream to “Measurement” module

This function enables you to pass the actual stream to the measurement module. Enable the „Measure“ mode and click on the „Pass stream to “Measurement” module“ button. The live stream is now available in the *Measurement* module. Use the utilities of the *Measurement* module for live analysis.



**Note:** If the Measurement module was not used since start of the software, load it manually.



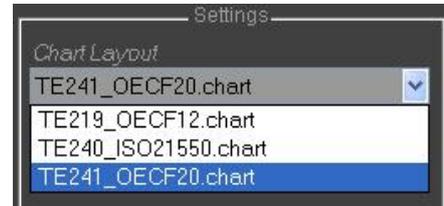
## 8 MODULES

### 8.1. Settings

This section is about the options that are available in all modules (OECF, Color, Resolution,...). The module specific information is described later in the module related chapters.

#### Chart layout

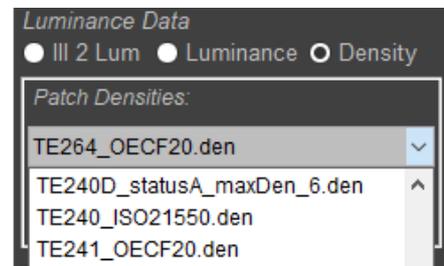
At the top of the settings in each module you can select the chart layout file which is suitable to your test image. It contains all necessary information about the test chart. For the Histogram module there are no specific layouts but a selection of black, white or gray image.



select the chart layout

#### Reference Data

Most modules require a reference file with default or measured optical densities or colors. By using the dropdown menu you can choose the reference data for the chart layout.



select the reference data

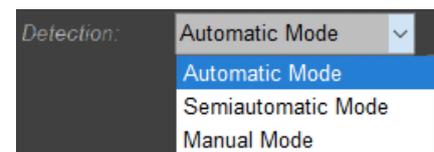
#### Calculate visual noise

Some of the modules offer the calculation of visual noise. If you like to compute this data, mark up the checkbox. The result will be saved and displayed in the graphical representation. Note, that this will increase the processing time.



#### Detection

By using the dropdown menu you can choose if the ROI (Region of Interest) selection is done automatically or manually. There is also a new option for the FreeEdge layout in the resolution module called Fix Mode. Fix Mode allows you to store the location of manually set ROIs to use them for future analysis. Note that not all modules offer the Manual Mode option.



*Automatic mode:* Default and recommended mode. The software detects all ROIs automatically and starts analysis immediately. In most cases the automatic mode works reliable. If all ROIs were detected properly can be seen in the check image.

*Semiautomatic mode:* The software detects the pattern and displays the ROIs which can be adjusted.



*Manual Mode:*

After pressing the „Start“ button you need to crop the image and then adjust the ROIs manually. Depending on the chart layout in some modules you need to do only one of these steps. Instructions about next steps are displayed in the head line of the window. To adjust the rectangles activate them by clicking at the edge. You can move them or, depending on the module, adjust the size. Continue until all ROIs fit your test image.

A right mouse click offers some more functions:

*Copy position:* Copy position to clipboard. A Matlab feature not further used in the iQ-Analyzer

*Set Color:* Changes color of the rectangles. It has no influence on further calculation

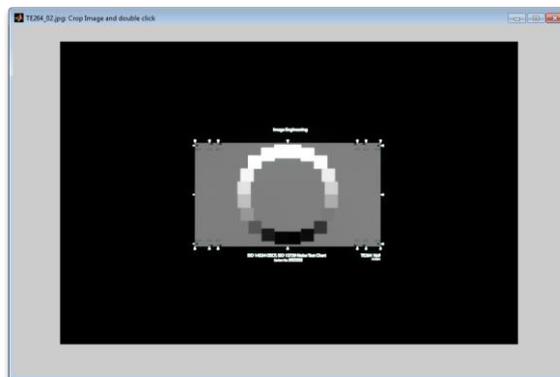
*Fix aspect ratio:* Aspect ratio of a rectangle is fixed

*Crop Image:* Crops the image

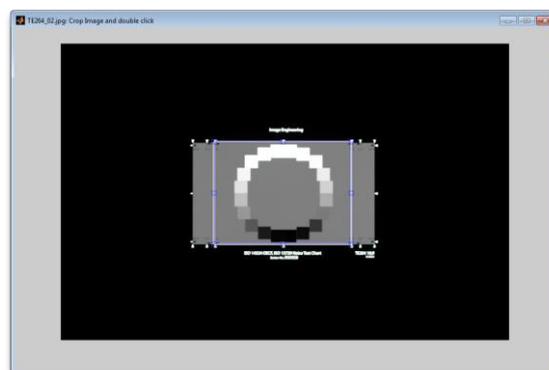
*Cancel:* Cancels operation, closes window and returns to iQ-Analyzer module

Example:

- I. Select the OECF test pattern by drawing a rectangle around it with aspect ratio of 4:3. Double click on it to confirm the selection.



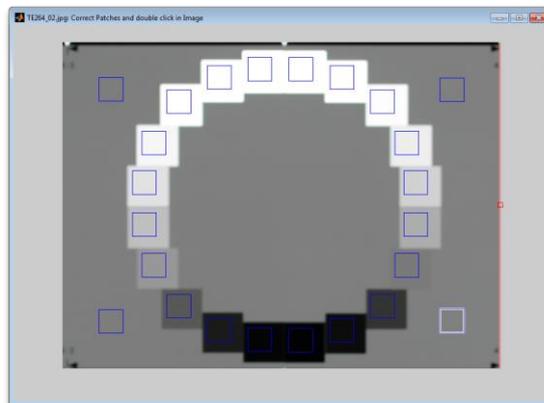
window for manual ROI detection



rectangle around the TE241 (aspect ratio 4:3)



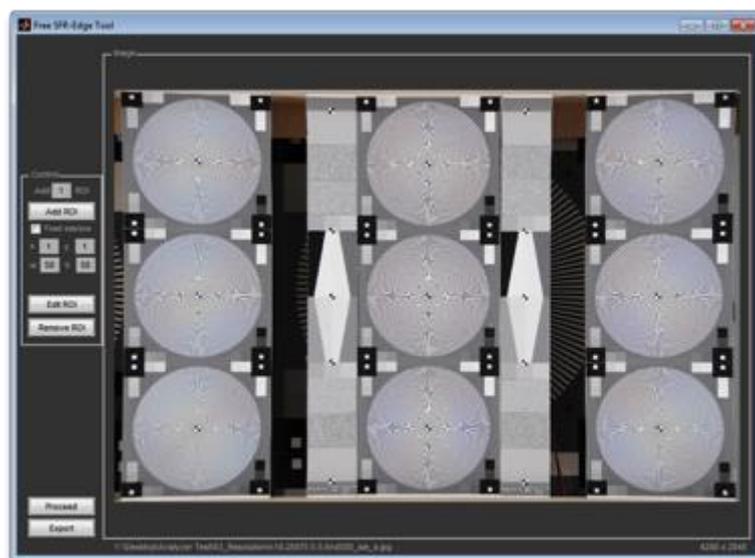
II. The ROIs are indicated by rectangles. Activate the rectangles by clicking on the edge. Now you can adjust the ROIs manually.



TE241 and ROIs

III. When the manual adjustment of ROIs is done press any key and the analyzing process starts.

*Manual Mode (FreeEdge):* The Manual Mode for the FreeEdge chart layout is designed slightly different. This tool is only available in the Resolution Module for the SFR analysis of slanted edges.



#### **Add a defined number of ROIs**

Insert the number of ROIs you want to add to the image. After confirming by clicking the „Add ROI“ button you can adjust the size and position of the ROIs. To add further ROIs repeat the process.

#### **Fixed size/pos**

Define the position and the size of a ROI in pixel. The added ROI will appear at the defined position and has the defined size.



### Edit ROI

Activate this button and click inside of a ROI. The outline of the ROI becomes adjustable.

### Remove ROI

Activate this function and click inside of a ROI. The ROI will be deleted.

### Proceed

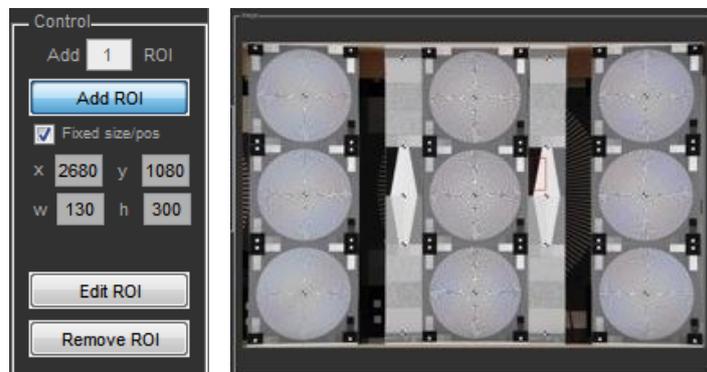
Proceed starts the analysis of all inserted ROIs.

### Export

Export the positions of the ROIs as text file. The file can be used again for later analysis.

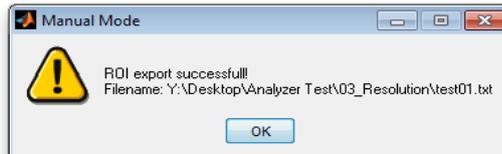
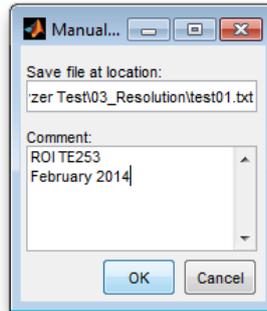
### Example:

- I. Select the *TE000\_FreeEdgeChart.chart* layout file, choose Manual Mode and press „Start“.
- II. Adjust the size and the position and add one ROI. The ROI appears in the image.



adjustment of ROI position and inserted ROI

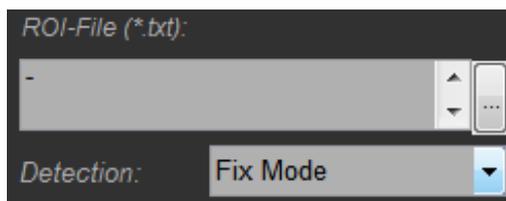
- III. Press „Export“. A menu appears where you can adjust the file name and add a comment. Save this file to your preferred location. By default it will be saved in the folder of the image file.



IV. Press „Proceed“ to start the analysis.

*Fix Mode (FreeEdge):*

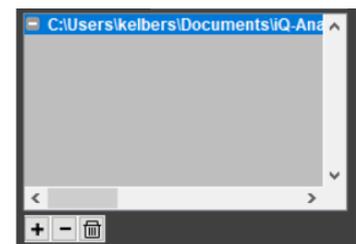
Choosing *Fix Mode* from the list requires to load a text file which was created once before in the *Manual Mode*.



Click on the „...“ button and select the appropriate text file. When starting the analysis, the iQ-Analyzer will calculate the results for the ROIs which are defined in this text file.

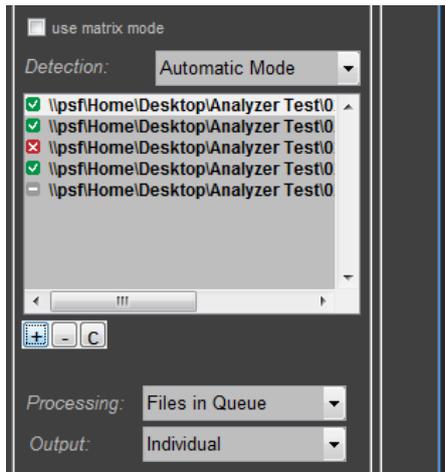
## Files

Files for analysis can be added to the file list using the „+“ button. Delete selected files with the „-“ -button and clear the list with the trashcan button.





The file list displays icons before each file path which show the status of each file:



The gray dash informs you that the file is not processed yet.

A green check marks a file which analysis is completed.

A red cross shows that analysis failed. Information about the error is shown in a popup window.

### Analyze calculated images again

If you add new files to the list with already analyzed images, you can choose if you want to analyze all images again or just analyze the new images.

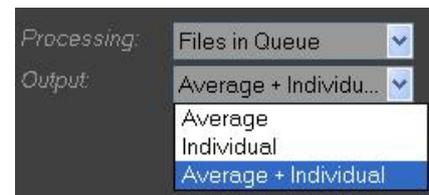
### Processing

- Files in Queue:* All files added to the file list will be analyzed
- Files in Queue + Ext.:* Select „Files in Queue + Ext.“ if you have an image series. The files need to be named with extensions (e.g. colorchecker\_01, colorchecker\_02, colorchecker\_03, ...). Add the file with the lowest extension to the list. The iQ-Analyzer automatically will analyze the entire series. If your extensions are not numerical, you can specify them in the settings.

### Output

By using the dropdown menu below the file list you can configure the output properties.

- Individual:* Separate results for every image are saved in a text file
- Average:* The averaged results of the entire image sequence are saved in a text file (only available for „Files in Queue + Ext.“)
- Average+Individual:* The average and individual results are saved in one or multiple textfiles, depending on the output settings in *General Settings*.



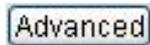


### Start

Press the „*Start*“-button to start the analyzing process. In the upper frame you see a progress bar. The numerical results and a check image with marked ROIs are saved automatically as .txt and .jpg files, depending on your export settings in the *General Settings* menu.



## 8.2. Advanced Settings



Pressing the „*Advanced*“ toggle button at the bottom of the settings opens the advanced settings menu. Pressing this button again hides the advanced settings menu. A description of the *Advanced Settings* is included in the chapter of the regarding module.



### 8.3. OECF

With a gray scale test chart the Opto Electronic Conversion Function (OECF) can be determined. The OECF describes the characteristic property of digital cameras to transfer the luminance of a scene into digital values in the image. The curve is specified for all three color channels, red, green and blue.



OECF tab

In order to determine the OECF, the test chart needs to be illuminated homogeneously. Regarding exposure there are two recommendations, one for the old and one for the actual version of ISO standard 15739. For the outdated version, ISO 15739:2003, we recommend to choose an exposure setting on the camera that the brightest patch is in full saturation and the second brightest is not. That way you can get comparable results between different cameras. In the actual version, ISO 15739:2013, the digital value of the test chart background should be equal to 118.

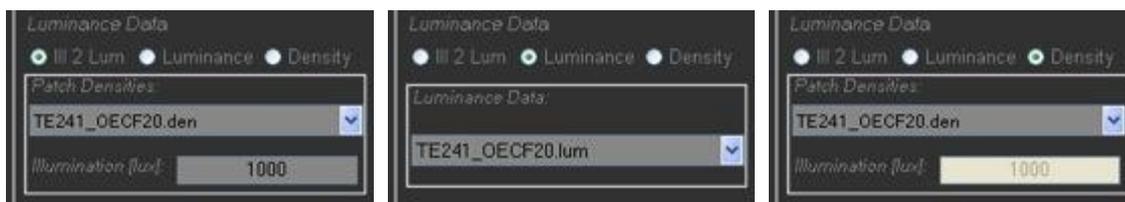
#### 8.3.1. Settings

##### SETTINGS

After selecting the chart layout the OECF module needs the following adjustment:

##### Luminance Data

As the OECF is a function of digital value over luminance of a target, you need to provide the actual luminance of each patch in  $\text{cd/m}^2$ . You can choose between three options:



Ill 2 Lum

Luminance

Density

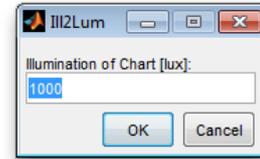
**Ill to Lum:** Illumination to luminance is a simple, not quite accurate method which doesn't require a luminance meter. The luminance is calculated from the chart illumination in lux and the densities of the chart patches.

**Patch Densities:** Choose the density file of the chart, e.g. TE240\_ChartNo1.den. The default folder for the .den files is C:\ProgramData\Image Engineering\iQ-Analyzer V6.2.X.X\Data.



In the Advanced Settings you can create your own density files, import existing ones, or make changes according to the datasheet, which is delivered with the test chart, and save them.

**Illumination [lux]:** Insert the measured illumination on the chart in lux. If you do not insert a value for illumination, a popup window will appear when you press the „Start“ button.



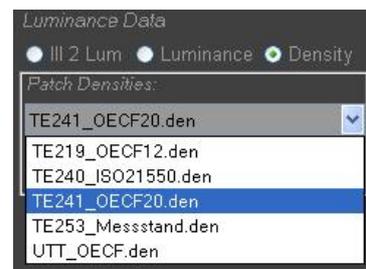
popup if illumination is not set

**Luminance:** This is the most accurate method as you can apply you own luminance measurements as a reference.

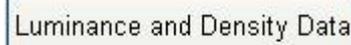
**Luminance Data:** Select the file for luminance data. In the Advanced Settings you can import already existing luminance data, edit and save it.

**Density:** This method is recommended for devices with constant illumination, e.g. scanner. The OECF analysis is calculated directly with the optical density. In the graphical results the OECF can be displayed with luminance, density or reflectance.

**Patch Densities:** Select the density file of the choosen chart, e.g. TE241\_OECF20.den.



In the Advanced Settings you can create your own density files, import existing ones, make changes according to the datasheet which is delivered with the test chart, and save them.

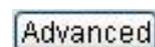


By using this button in the “Advanced Settings” menu you can create your own density files and/or edit existing ones

**Note:** Take care when using tele-photometers (e.g. Minolta LS). In dark patches the measured luminances can differ because of stray light in lenses.

## ADVANCED SETTINGS

By using the toggle button “Advanced” the Advanced Menu appears or disappears.





### V/N – Ignore for Mean

This option is used for average calculation of visual noise (VN). It can happen that more than one field is in full saturation. To reduce the influence of fields in full saturation (VN equals zero), you can set the amount of fields that are ignored for calculation.

*First/Last:* The first and the last field will be ignored

*First2/Last2:* The first and last two fields will be ignored

*None:* All fields are taken into account

### Measure temporal noise

Activate this option if temporal noise shall be calculated. This is possible if you have captured a minimum of eight images. The ROI position is not corrected for all images of the series to determine the temporal noise information. Using this option requires to select „Files in Queue + Ext.“.

### III 2 Lum Factor

Set a factor for the calculation of luminance if you have selected „III 2 Lum“ under Luminance Data. The factor depends on the measurement setup and takes differences in the spherical illuminator and the measuring head into account. The „III 2 Lum Factor“ does not influence the results and dynamic range. Default value: 1

The „III 2 Lum Factor“ is calculated by the formula:

$$III2LumFactor = \frac{LUMINANCE}{\frac{ILLUMINATION}{\pi} * 10^D}$$

With this factor the luminance for every patch will be calculated which is required for the calculation of the OECF.

$$LUMINANCE = \frac{\frac{ILLUMINATION}{\pi} * 10^D}{III2LumFactor}$$

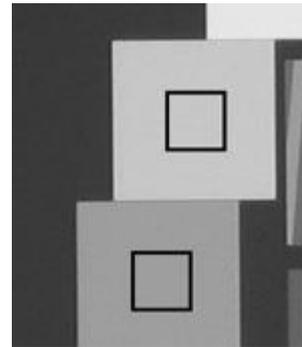
ILLUMINATION: Illumination in the brightest patch

D: Density of the brightest patch



### Limit Patch Size to

To reduce calculation time you can limit the size of the analyzed patches.

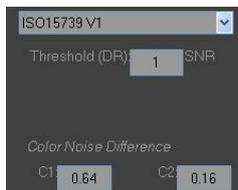
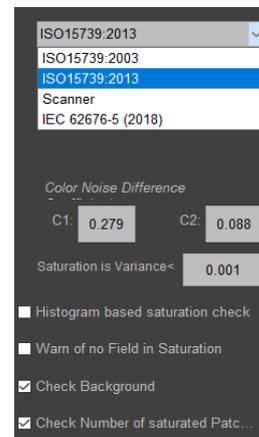


### Standards

By using the dropdown menu you can select between the different standards. Switching between the standards changes the following options.

### Threshold (DR)

The Dynamic Range (DR) is the calculated distance between the illumination needed to reach saturation and the minimum saturation limited by a specified SNR (signal to noise ratio). The standard use for ISO 15739 is SNR = 1. This may lead to problems due to signal processing and noise reduction, as a SNR of 1 is never reached. Therefore the threshold might be increased.



**Note:** We have good experience using a threshold of three. You should mention the threshold if deviating from ISO when reporting the dynamic range.

### Color Noise Difference

The color noise difference coefficients C1 and C2 for the calculation of the total noise  $\sigma_{total}$  are changed automatically according to ISO:

$$\sigma_{total} = \sqrt{\sigma_Y^2 + C_1 \sigma_{R-Y}^2 + C_2 \sigma_{B-Y}^2}$$

ISO 15739:2003

C1 = 0.64, C2 = 0.16

ISO 15739:2013:

C1 = 0.279, C2 = 0.088

Scanner:

Equal to ISO 15739:2003



## Histogram based saturation check

The exact definition of “saturation” is not very precise in the ISO standard. We discovered issues here and added

the functionality to check for saturation based on a histogram analysis. “Saturation” is reached when 50% of all pixel in a ROI have the same value and no larger value is available. This is typically 255 for an 8 bit image, but can also be lower.

Enabling this setting will lead to more stable and robust results, but dynamic range will be measured lower and it is not compliant with current ISO standard. This method is under discussion within ISO and might become part of a future revision.

Histogram based saturation check

## Warn of no Field in Saturation

If the checkbox is enabled a warning appears if no field is in saturation. According to ISO 15739:2003, exposure is adjusted to the saturated field, this checkbox is automatically enabled when ISO15739:2003 is chosen.

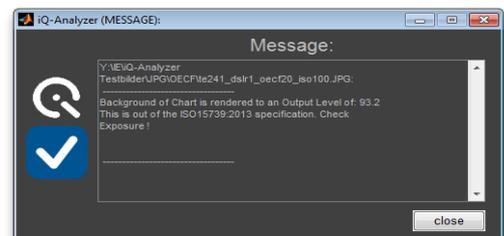
Saturation is Variance < : Saturation is equal to variance = 0. However, if there is fixed pattern noise, the variance can be greater than zero although the image is saturated. To avoid this effect you can increase this tolerance value.

Warn of no Field in Saturation  
Saturation is Variance < 0.001

## Check Background

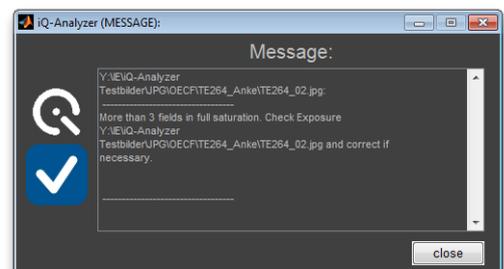
According to ISO 15739:2013 the exposure is adjusted to the test chart background with a digital value DV of 118 (range between 100 and 140) in sRGB (CIE-L\* = 50). If the checkbox is enabled a warning appears if the required values are not reached. This checkbox is automatically enabled when ISO 15739:2013 is chosen.

Check Background



## Check number of saturated Patches

If more than three patches are in saturation a warning is displayed This is important for calculation according to ISO 15739:2003.





## Luminance and Density Data

To create new luminance and density data or edit existing files use the button „Luminance and Density Data“.

Luminance and Density Data

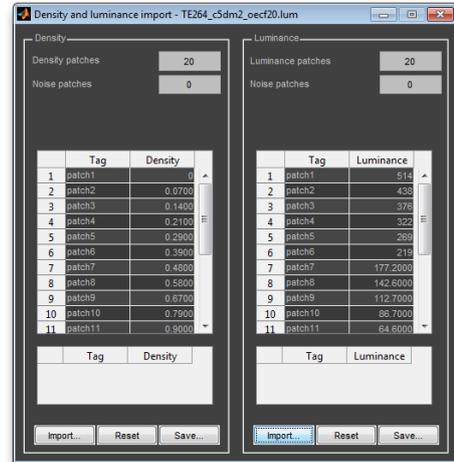
An editing window appears. On the left side the density values for the patches can be entered, on the right side the luminance values.

Depending on the chart insert the number of patches used for OECF and for noise measurement. For every patch the density or luminance values have to be inserted.

You can enter data either manually or use the “Import” button to import existing files. Possible files are .den, .lum, .I20, .I12, .txt files for density and luminance. The structure of the txt files that can be imported has to be as follows:

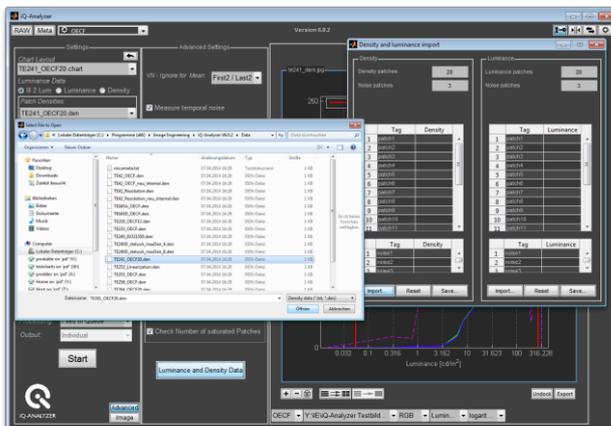
*First row:* Density/luminance values (decimal points) separated by using tabs

*Second row:* Values of the three noise patches (decimal points) separated by using tabs

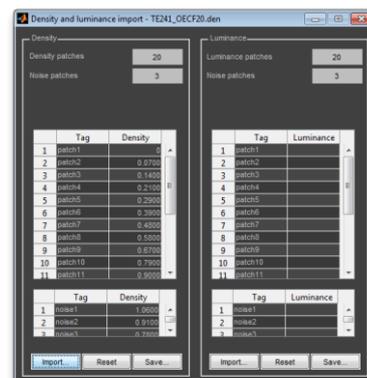


.txt file of density/luminance data

You can save your settings by using the „Save“-button and clear the list by using the „Reset“-button. To use your created/edited data, you need to save the data into the folder which is defined in the settings under OECF Reference Data Location. The local folder „Data“ is set as default.

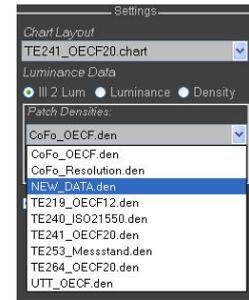


Density/luminance import



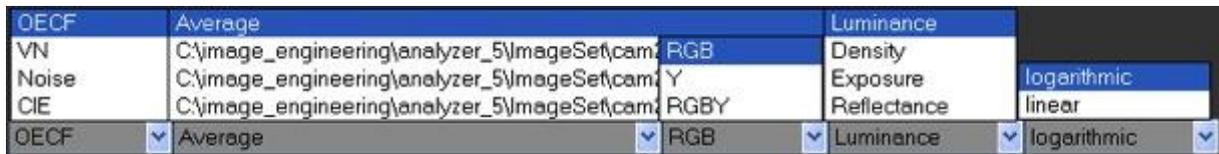


After saving, close the window and your new created density or luminance data will appear in the dropdown list.

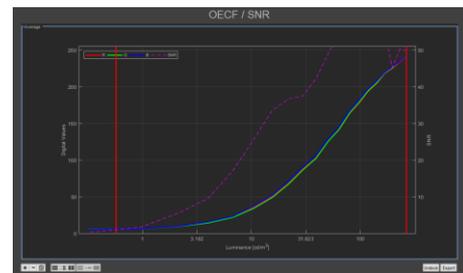


### 8.3.2. Graphical presentation

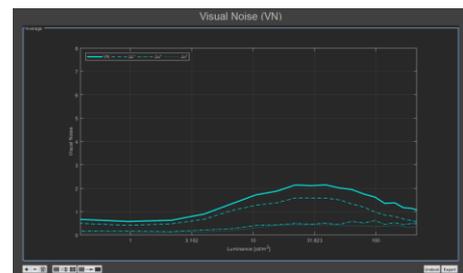
Below the graph some drop down menus are located. The first one allows choosing the result you want to be displayed, OECF, Visual Noise VN, Noise or CIE.



**OECF:** The OECF of the analyzed images are shown. It is a function of the digital value depending on the luminance. The two red vertical lines show the dynamic range of the device under test. Settings for the dynamic range can be made in the Advanced Menu. The lower limit you define in "Threshold".

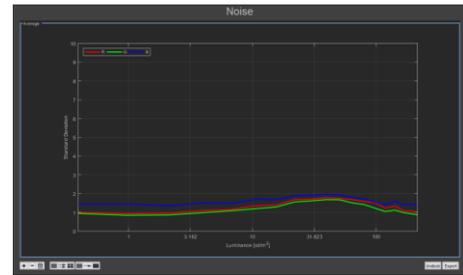


**VN:** The Visual Noise for the three Viewing Conditions are displayed which are defined in the "Settings".

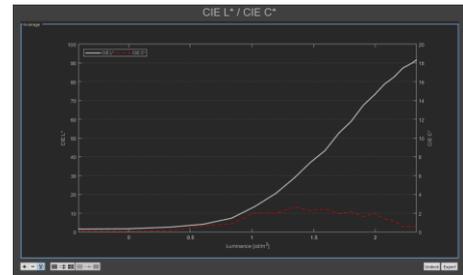




**Noise:** Noise displayed as Standard Deviation. The standard deviation is defined as the square root of the absolute value of the sum of variances in the signal region.



**CIE:** Presentation of luminance L and chrominance C, defined in the CIE LCh color space. The colorspace has the shape of a sphere with the three axes L, C and H (hue, colortone). The L axis is vertical from 0, which has no lightness, at the bottom, to 100 which is maximum lightness at the top. The C axis ranges from 0 at the center of the circle, which is completely unsaturated (i.e. a neutral gray, black or white) to 100 at the edge of the circle for maximum chroma or saturation.



By using the second drop down menu you can choose between result representation of a particular image file or the representation of the average. This applies only if you have set the processing and output options to „Files in Queue + Extension“ / „Average“.

The third dropdown menu contains a selection of components that will be displayed in the graph, color components RGB, the luminance Y or RGBY.

The fourth dropdown menu allows showing a representation based on luminance, density, exposure or reflectance. The further menus are depending on the previous ones.



### 8.3.3. Numerical results

#### SNR

SNR is defined as the ratio of the signal value to the standard deviation of the signal value. iQ-Analyzer calculates a Y (luminance) image and uses this for further calculations. The results are also indicated as digital values [DV].

The results differ depending on the ISO 15739 version, which is set in the advanced settings because of the varying calculation of noise and exposure. ISO 15739:2003 applies the three noise patches contained in the chart layout, ISO 15739:2013 measures noise within the OECF patches.

The following calculations are based on the ISO 15739:2013. For the chart based OECF the reference luminance ( $L_{ref}$ ) shall be determined as the luminance corresponding to a digital level of 245 on the OECF function. The total, fixed pattern and temporal signal to noise ratios are measured at the luminance that is 13% of the luminance at the reference exposure:

$$L_{SNR} = 0.13 * L_{ref}$$

$L_{ref}$  : Inverse logarithm of the log luminance value at the reference exposure  $R_{ref}$

$R_{ref}$  : Log luminance value at the reference exposure

$$R_{ref} = S^{-1}(I)|_{I=245}$$

**SNR<sub>total</sub>:** Total noise means all unwanted variations captured by a single exposure. The signal to noise ratio is determined by:

$$SNR_{total} = \frac{L_{SNR} * gain_{incrementd}}{\sigma_{total}}$$

$$S_{total} = \sqrt{S_y^2 + C_1 S_{R-Y}^2 + C_2 S_{B-Y}^2}$$

$$\sigma_{total} = \sqrt{\frac{1}{n} \sum_{i=1}^n \sigma_{total,i}^2}$$

$\sigma_{total}$  : Standard deviation of the total noise (STD<sub>total</sub>) for a single image and for multiple images when analyzing n images

**SNR<sub>total</sub>[db]:** SNR<sub>total</sub> in db.

**STD<sub>total</sub>[DV]:** Mean standard deviation of all gray patches.

**SNR<sub>temp</sub>:** Temporally varying noise means random noise due to the sensor dark current, photon shot noise, analogue processing and quantization, which varies from one image to the other. If you have captured a minimum of eight images in a single session, the temporal SNR will be calculated. The temporal SNR is determined by measuring the standard

SNR <sub>total</sub>	41.6	
SNR <sub>total</sub> [dB]	32.4	
STD <sub>total</sub> [DV]	1.7	
SNR <sub>temp</sub>	-	
SNR <sub>temp</sub> [dB]	-	
STD <sub>temp</sub> [DV]	-	
SNR <sub>fp</sub>	-	
SNR <sub>fp</sub> [dB]	-	
STD <sub>fp</sub> [DV]	-	
	mean	max
VN (1)	1.6	2.1
dL (1)	1.1	1.6
du (1)	0.4	0.6
dv (1)	0.3	0.4
VN (2)	0.6	0.8
dL (2)	0.5	0.6
du (2)	0.1	0.2
dv (2)	0.1	0.2
VN (3)	0.7	1.0
dL (3)	0.5	0.8
du (3)	0.2	0.2
dv (3)	0.1	0.2
DR <sub>total</sub> [f-stop]	8.85	
DR <sub>total</sub> [D]	2.67	
DR <sub>total</sub> [dB]	53.31	
DR <sub>temp</sub>	-	
DR <sub>temp</sub> [D]	-	
DR <sub>temp</sub> [dB]	-	
WB [DV]	1.4	
WB [C]	1.3	
DR [DV]	236.8	
ISO sat	-	
ISO S/N10	4000	
ISO S/N40	500	



deviation of the difference of each image and the average image and applying a correction to determine the true level of the temporal noise.

$$SNR_{temp} = \frac{L_{SNR} * gain_{incrementd}}{\sigma_{temp}}$$

$\sigma_{temp}$  : Standard deviation of the temporal noise (STD\_temp)

$$\sigma_{temp} = \sqrt{\frac{n}{n-1} \sigma_{diff}^2}$$

$\sigma_{diff}$  : Average standard deviation of the code values of all the differences of the average and the individual images that make up the average

*SNR\_temp[db]*: SNR\_temp in db.

*STD\_temp[DV]*: Temporal standard deviation, mean value of all gray patches.

*SNR\_fp*: Fixed pattern noise means unwanted variations which are constant for every exposure. The ISO standard camera fixed pattern SNR is determined by:

$$SNR_{ISO\_FP} = \frac{L_{SNR} * gain_{incrementd}}{\sigma_{fp}}$$

$$\sigma_{fp} = \sqrt{\sigma_{ave}^2 - \frac{n}{n-1} \sigma_{diff}^2}$$

$\sigma_{fp}$  : Standard deviation of the fixed pattern noise STD\_fp

$\sigma_{ave}$  : Standard deviation of the code value of the average of „n“ images

$\sigma_{diff}$  : Average standard deviation of the code values of all the differences of the average and the individual images that make up the average

*SNR\_fp[db]*: SNR\_fp in db.

*STD\_fp[DV]*: Standard deviation of fixed pattern noise, mean value of all gray patches.

### Visual Noise (VN)

The numerical value for Visual Noise is a weighted sum of the standard deviation of each channel in the CIE-Luv colorspace. To give further insight into the noise characteristics we also provide the following values for all three viewing conditions that can be specified in the settings:

- VN*: Weighted sum of standard deviations in CIE-Luv for the three defined viewing conditions
- dL (delta L)*: Standard deviation in CIE L\*
- du (delta u)*: Standard deviation in CIE u
- dv (delta v)*: Standard deviation in CIE v



## Input (referred results)

*DR\_total*: The total dynamic range is provided in f-stops,  $DR\_total[f\text{-stop}]$ , and density,  $DR\_total[D]$ . It applies to ISO 15739:2013 and for outdated version ISO 15739:2003. The ISO DSC (Digital Still Camera) dynamic range is the ratio of the maximum unclipped luminance level  $L_{sat}$  to the minimum luminance level that can be reproduced with a signal to noise ratio of at least 1,  $L_{min}$ .

$$ISO.DSC.dynamicrange = \frac{L_{sat}}{L_{min}}$$

$$L_{min} = L_{(SNR=threshold)}$$

$L_{(SNR=threshold)}$ : Default threshold is SNR=1

In case the threshold can not be reached a 2.0 density „black reference“ is used to calculate the dynamic range in order to avoid black level clipping problems.

The value for  $L_{min}$  shall be calculated as

$$L_{min} = \frac{\sigma_{total}(2.0)}{incremental.gain}$$

$$\sigma_{total}(2.0) = \sqrt{\frac{1}{n} \sum_{i=1}^n \sigma^2_{total,i}}$$

$\sigma_{total}(2.0)$ : The black total noise measured at density of 2.0

$DR\_total$  is stated in f-stops,  $DR\_total[f\text{-stop}]$ , optical densities,  $DR\_total[D]$ , and dB,  $DR\_total[db]$ .

*DR\_temp*: The temporal dynamic range is only available when using the new version of ISO 15739 standard, ISO 15739:2013.

In case the threshold can not be reached a 2.0 density „black reference“ is used to calculate the dynamic range in order to avoid black level clipping problems.

The value for  $L_{min}$  shall be calculated as

$$L_{min} = \frac{\sigma_{temp}(2.0)}{incremental.gain}$$

The black temporal noise is derived by measuring the standard deviation of the difference of each image and the average image and then applying a correction to determine the true level of the temporal noise:



$$\sigma_{temp}(2.0) = \sqrt{\frac{n}{n-1} \sigma_{diff}^2}$$

$\sigma_{temp}(2.0)$ : Standard deviation of the temporal noise

$\sigma_{diff}$ : Average standard deviation of the code values of all three differences of the average and the individual images that make up the average

DR\_temp is stated in f-stops, optical densities, DR\_temp[D], and dB, DR\_temp[db].

### Output (referred results)

**WB [DV]:** Whitebalance represented in digital values. The mean difference between red-green and blue-green. As the chart is perfect gray the ideal would be 0.

**WB [C]:** Average of the CIE-C (chrominance) values

**DR [DV]:** Dynamic range, stated in digital values, shows the difference between mean digital value of the brightest and the darkest patch.

### ISO

The ISO speed is calculated. There are three different definitions in the ISO standard. The idea is to measure the light intensity on the sensor which leads to a specific result in the image:

**ISO sat:** saturation based ISO speed; the ISO speed is calculated on the light intensity that is needed to reach saturation

**ISO S/N10:** noise based ISO speed; the ISO speed is calculated on the light intensity that is needed to reach a signal to noise ratio of 10 (first acceptable)

**ISO S/N40:** noise based ISO speed; the ISO speed is calculated on the light intensity that is needed to reach a signal to noise ratio of 40 (first excellent)

**Note:** To get reliable results from the ISO speed measurement, you should make sure that the „Luminance Data“ is set correctly. We strongly recommend to measure the luminance on each patch directly, so to specify a *myLuminances.lum* file rather than a *myDensities.den* file and the illumination. Under some circumstances the effective aperture can differ significantly from the numerical aperture, so make sure that you have specified the focal-length and the object distance in the META module.



## 8.4. COLOR

In the Color module you can analyze images due to their color reproduction quality. You should consider that a perfect color reproduction could, but must not, lead to a “nice looking” image. The color charts, e.g. the ColorChecker SG, have to be illuminated homogenously.

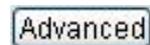


“Color” tab

### 8.4.1. Settings

#### ADVANCED SETTINGS

By using the toggle button „Advanced“ the advanced menu opens.



#### Display Profile

By using the „...” button you can select an icc/icm profile for your display. If no display profile is selected, sRGB is used.

#### Color Difference Formula

The iQ-Analyzer calculates two Lab data sets, the reference and the image sample. From this data the color difference Delta E is calculated.

You can choose between three methods and formulas for calculation of color differences (most common is CIE1976):

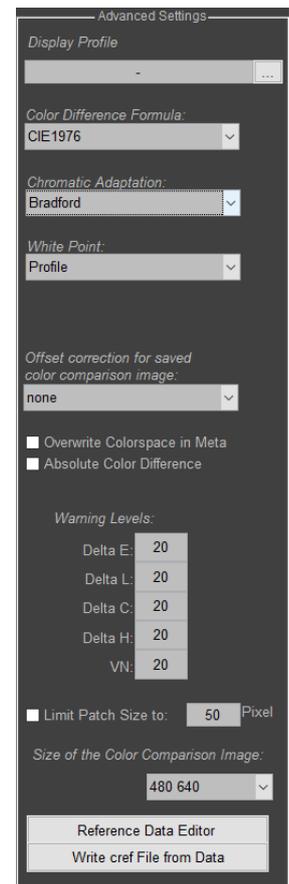
$$CIE1976: \quad \Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

$$\Delta L = L_{reference} - L_{sample}$$

$$\Delta a = a_{reference} - a_{sample}$$

$$\Delta b = b_{reference} - b_{sample}$$

If you express the Lab in polar coordinates you get *LCh*, where *L* is the luminance, *C* the chrominance (saturation) and *H* the hue (colortone). *Delta E* indicates the overall difference between reference and sample. To get more detailed information about the difference it is interesting to see the difference in Luminance *Delta L* and hue *Delta H*.



Advanced settings of the color module



$$\Delta L = L_{reference} - L_{sample}$$

$$\Delta C = C_{reference} - C_{sample}$$

$$\Delta H = \sqrt{(\Delta a)^2 + (\Delta b)^2} - \Delta C^2$$

CIE1994:

$$\Delta E = \sqrt{\left(\frac{\Delta L}{k_L S_L}\right)^2 + \left(\frac{\Delta C}{k_C S_C}\right)^2 + \left(\frac{\Delta H}{k_H S_H}\right)^2}$$

In iQ-Analyzer the following parameters for graphic and photography are used:

$$k_L = k_C = k_H = 1$$

$$S_L = 1$$

$$S_C = 1 + 0.045 C_{sample}$$

$$S_H = 1 + 0.015 C_{sample}$$

CIE2000 (1:1:1):

$$\Delta E = \sqrt{\left(\frac{\Delta L}{k_L S_L}\right)^2 + \left(\frac{\Delta C}{k_C S_C}\right)^2 + \left(\frac{\Delta H}{k_H S_H}\right)^2} + R_T \left(\frac{\Delta C}{k_C S_C}\right) \left(\frac{\Delta H}{k_H S_H}\right)$$

Compared to CIE1994 the rotation term is added as the fourth element. This term only takes effect in the blue region.

CIE2000 SL1:

$$\Delta E = \sqrt{\left(\frac{\Delta L}{k_L S_L}\right)^2 + \left(\frac{\Delta C}{k_C S_C}\right)^2 + \left(\frac{\Delta H}{k_H S_H}\right)^2} + R_T \left(\frac{\Delta C}{k_C S_C}\right) \left(\frac{\Delta H}{k_H S_H}\right)$$

Compared to CIE1994 (see next method) the rotation term is added as the fourth element. This term only takes effect in blue region.

### Chromatic Adaption

The Lab TIFF specification, the ICC profile specification and Adobe Photoshop all use a D50, 2° standard observer for *Lab*. So all working spaces that are not similarly defined have to be adapted from their native reference white to D50. For doing this operation different methods could be used. The chromatic adaptation algorithms may all be implemented as a linear transformation of a source color ( $X_S, Y_S, Z_S$ ) into a destination color ( $X_D, Y_D, Z_D$ ) by a linear transformation [M] which is dependent on the source reference white ( $X_{WS}, Y_{WS}, Z_{WS}$ ) and the destination reference white ( $X_{WD}, Y_{WD}, Z_{WD}$ ):

$$[X_D \ Y_D \ Z_D] = [X_S \ Y_S \ Z_S] [M]$$



The idea behind all of these algorithms is to follow three steps:

1. Transform from  $XYZ$  into a cone response domain  $(\rho, \gamma, \beta)$ .
2. Scale the vector components by factors dependent upon both the source and destination reference whites.
3. Transform from  $(\rho, \gamma, \beta)$  back to  $XYZ$  using the inverse transform of step 1.

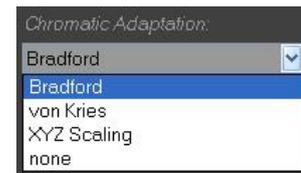
These steps are represented by these three matrices:

$$[M] = [M_A] \begin{bmatrix} \rho_D / \rho_S & 0 & 0 \\ 0 & \gamma_D / \gamma_S & 0 \\ 0 & 0 & \beta_D / \beta_S \end{bmatrix} [M_A]^{-1}$$

$$[\rho_S \quad \gamma_S \quad \beta_S] = [X_{WS} \quad Y_{WS} \quad Z_{WS}] [M_A]$$

$$[\rho_D \quad \gamma_D \quad \beta_D] = [X_{WD} \quad Y_{WD} \quad Z_{WD}] [M_A]$$

By using the dropdown menu you can choose a method for chromatic adaption. The differences among the three methods lie in the definition of the cone response domains  $[M_A]$ .



- Bradford:* The Bradford method is the newest of the three methods and is considered by most experts to be the best of them. This is the method used in Adobe Photoshop.
- von Kries:* Uses von Kries for chromatic adaption.
- XYZ Scaling:* XYZ Scaling is generally considered to be an inferior chromatic adaptation algorithm. Incidentally, this is the method that would result from transforming the source  $XYZ$  color to  $Lab$  using  $(X_{WS}, Y_{WS}, Z_{WS})$  followed by conversion back to  $XYZ$  using  $(X_{WD}, Y_{WD}, Z_{WD})$ .
- none:* No chromatic adaption method is used



Method	$[M_A]$			$[M_A]^{-1}$		
XYZ Scaling	1.0 0.0 0.0	0.0 1.0 0.0	0.0 0.0 1.0	1.0 0.0 0.0	0.0 1.0 0.0	0.0 0.0 1.0
Bradford	0.8951 0.2664 -0.1614	-0.7503 1.7135 0.0367	0.0389 -0.0685 1.0296	0.986993 -0.147054 0.159963	0.432305 0.518360 0.049291	-0.00825 0.040043 0.968487
Von Kries	0.40024 0.70760 -0.08081	-0.22630 1.16532 0.04570	0.00000 0.00000 0.91822	1.859936 -1.129382 0.219897	0.361191 0.638812 -0.000006	0.000000 0.000000 1.089064

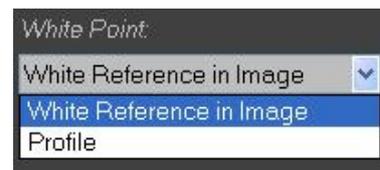
Definition of the cone response domains of the three methods for chromatic adaption

### White Point

By using the dropdown menu you can choose the image white point which is required for transforming XYZ to Lab.

*White Reference in Image:* The white patch in the image is used as white point

*Profile:* The white point saved in the image profile is used as white point



Selecting Image Reference White

Note: The profile is defined in the „Color Space“ option in the *Meta* section. E.g. if you select sRGB the sRGB profile is used.

### Offset correction for saved color comparison image:

*None:* No correction of the data.

*L\*:* All results of each patch are corrected by the offset in L\* between the average of all patches for the reference and for the image data. This will compensate for a general over- or underexposure.

*C\*:* All results of each patch are corrected by the offset in C\* between the average of all patches for the reference and for the image data. This will compensate for a general increase (or decrease) in saturation.

*L\* & C\*:* Both are applied.

### Overwrite Colorspace in Meta

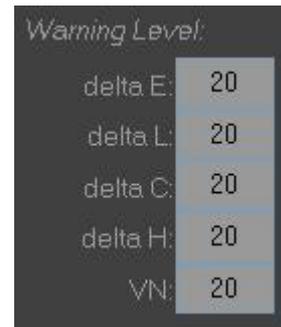
If this is enabled, the colorspace as selected will be used. This is useful if there is no colorspace information in the image data and the colorspace is known.



**Absolute Color Difference** Select this check box if you want to get results with absolute values. Absolute values only represent the amount of color differences, not the direction.

### Warning Levels

By inserting values for delta E, L, C, H and VN (Visual Noise) you can scale the color bar on the right of the graphical results.



warning level



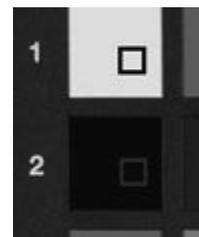
color bar

### Limit Patch Size to

To reduce calculation time you can limit the size of the analyzed patches. The default value is 50x50 pixel.



limit the patch size



patch size for analysis

### Size of the Color Comparison Image

In the color module a color comparison image is saved during the calculation. You can set the size of this comparison image.



dropdown menu for Color Comparison Image

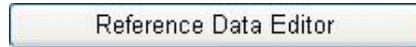


Color Comparison Image



## Edit/Create Reference Data

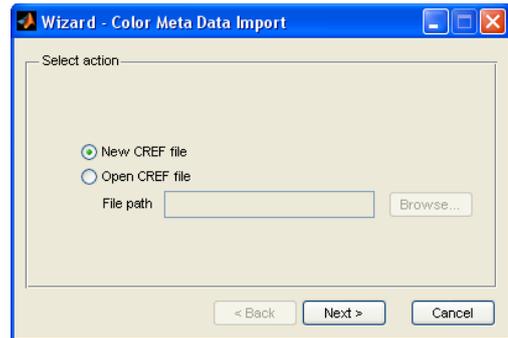
By using the button you can edit existing reference data or create new ones. Insert your own values or import existing files by using the „*Import ...*“ button.



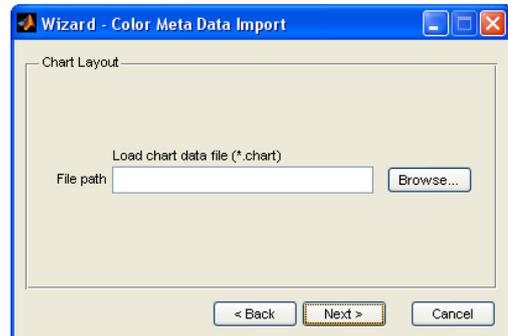
use the button to open the editing window

Pressing this button will start a wizard helping you to edit existing reference data or create new dataset.

*Select action:* Choose between creating a new reference dataset or opening an existing .cref file.

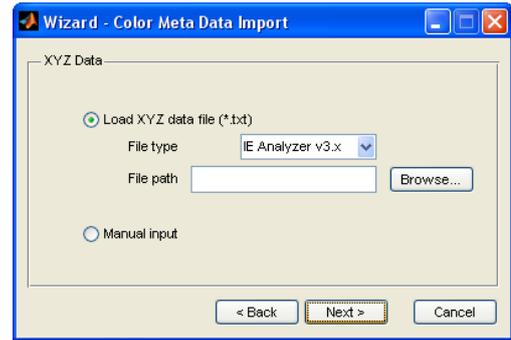


*Chart Layout:* Load chart layout data file (\*.chart) matching your chart to create new dataset. You will find these files in the *Chart* folder of your Analyzer installation.

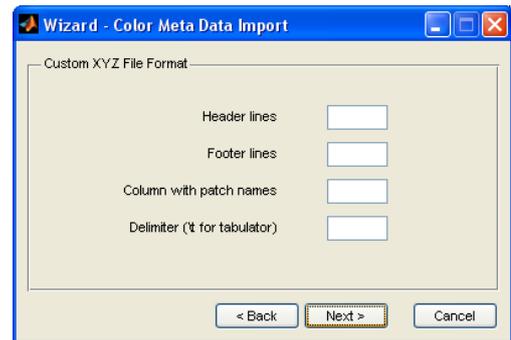




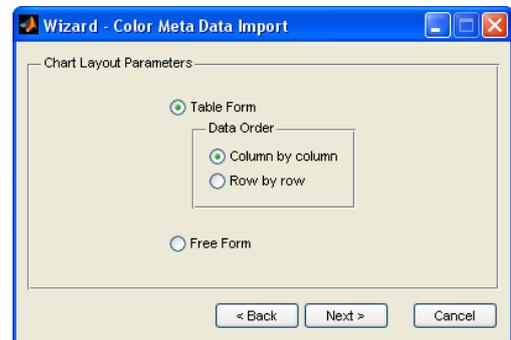
**XYZ Data:** You can load XYZ data from a text file or put it in manually. Supported data formats are iQ-Analyzer v3.x files, eyeOne/eyeOne Pro files or custom file formats. The measurement order for the IT-8 charts must be row by row.



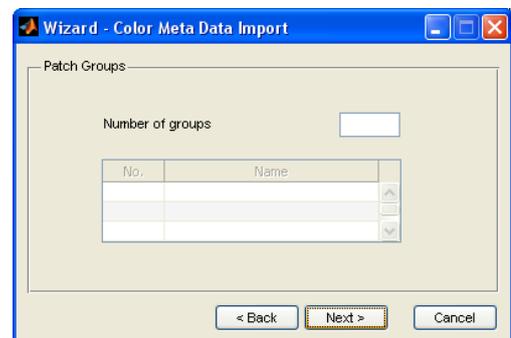
**Custom XYZ File Format:** If your XYZ dataset is available in a custom file format you need to provide information about the file structure. It concerns the number of header and footer lines, number of a column containing patch names as well as a delimiter character. Note that the data must be ordered in a table form.



**Chart Layout Parameters:** If the patches on your chart are ordered in a table form (e.g. Color Checker), select how data was obtained. Choose between *Column by column* and *Row by row* depending on the order the data was measured.



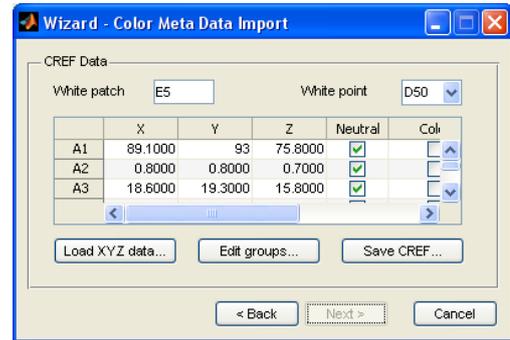
**Patch Groups:** You can create groups (e.g. *SkinTones*, *Glossy*) and assign them to the patches. Creating a new dataset the group *Neutral* will be created automatically and the *Color* group will be created while saving the file. Therefore these names are reserved and must not be used.





**CREF Data:** Here you can see and edit the reference data. If you have chosen to open existing reference file in the beginning you will immediately see this dialog.

Define or edit reference white patch which is used as white reference for further calculations and set the white point (D50, D55, D65, A, C).



Fill in or change XYZ data typing the values into the table.

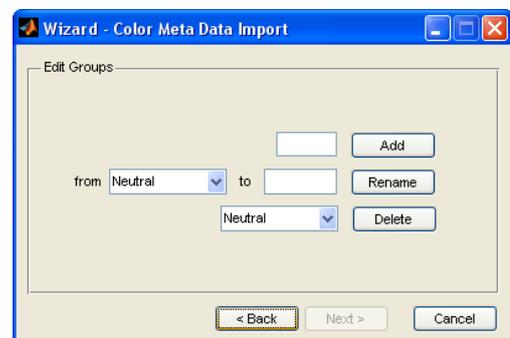
To assign a group to a patch click on the corresponding check box. Note that saving your file, a group *Color* will be created or updated, containing all the non-neutral patches referring to the check boxes in the *Neutral* column.

To load new or another XYZ dataset from a file use the *Load XYZ data...* button.

To edit groups press *Edit groups...* button. You will be able to add, remove and rename your groups.

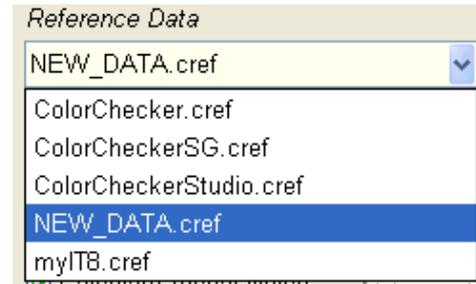
When done save your reference file by pressing *Save CREF...* button.

**Edit Groups:** You can add a new group putting its name into the empty field and pressing *Add*. To rename or remove a group choose it from the list, give it a new name in case of renaming and confirm your action with *Rename* or *Delete* respectively. Return to the *CREF Data* dialog pressing the *Back navigation* button.





In order to use the edited/created data, they have to be saved into the folder which is defined in the settings (Color Reference Data). The local folder *Data* is set as default.



dropdown menu with the new reference data

After closing the editing window you can select your new reference data in the dropdown menu

### Write cref File from data

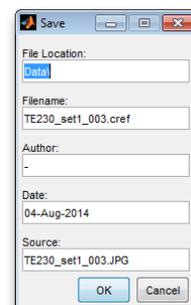


If you want to match all cameras in your studio or if you want to describe objectively how a new image pipeline changed the colors. You can make one camera or one setup to your "master" and compare how well another camera or other settings match these values.

First analyze the reference image. „White Point“ has to be set to „Profile“. This makes sure that the image data is not changed due to chromatic adaptations. Otherwise a warning dialog appears.



Press the button „Write cref File from Data“ and a window pops up. Make your settings and press „OK“. You should save the file at the current location of all the other .cref files. So this can be read in directly in the iQ-Analyzer dropdown menus.

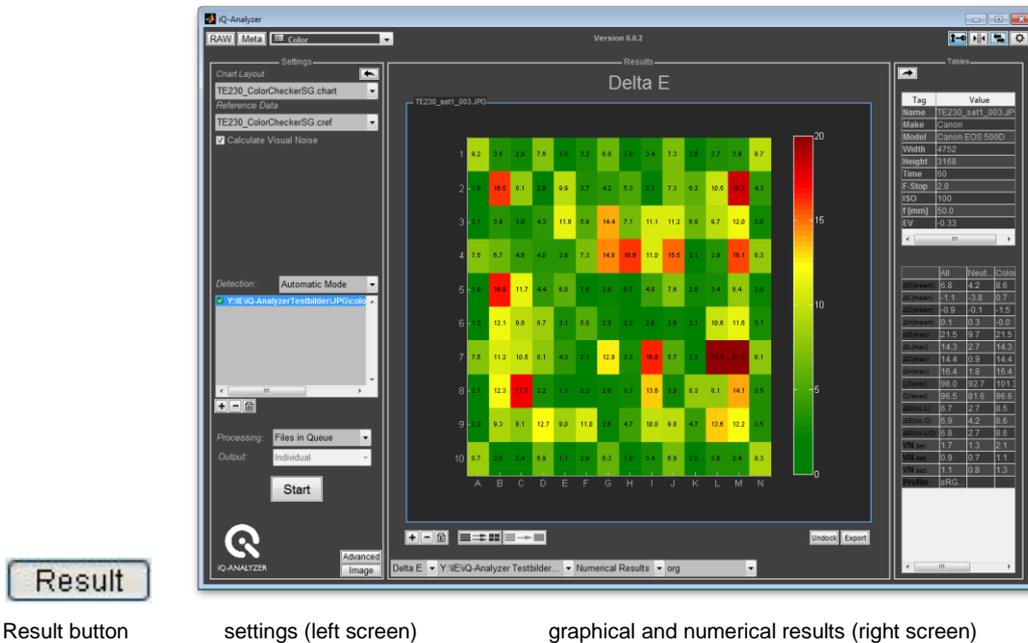


After you have saved the new .cref file, you can select this file in the reference file menu as *Reference Data*. Now you can make your measurements as you are used to do. The results you receive are now the difference of the current image to your master values.



### 8.4.2. Graphical presentation

By pressing the „Result“ button the results are displayed in the right screen.



Result

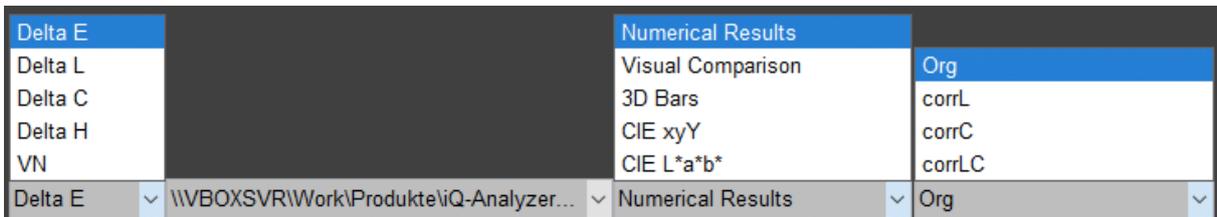
Result button

settings (left screen)

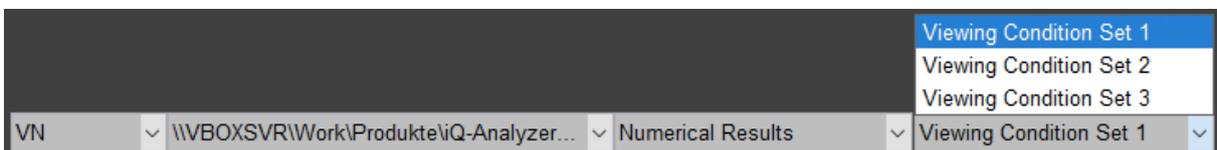
graphical and numerical results (right screen)

### Specific parameters

By using the left dropdown menu below the illustration you can choose which value shall be displayed: Delta E, Delta L, Delta C, Delta H or Visual Noise (VN).



dropdown menu for graphical representation (delta E, L, C, H)



dropdown menu for graphical representation (VN)

### Available files

By using the second drop down menu you can choose between result representation of the particular image file (file path is shown) and representation of the average if you have selected „Average“ in the output properties below the file list on the left side.

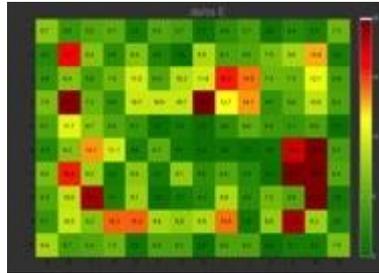


## Graphical presentation

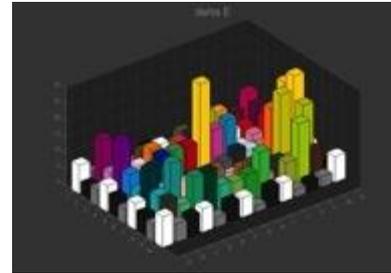
By using the third dropdown menu you can choose between displaying *Numerical Results*, *Visual Comparison* (Image vs. Reference), *3D Bars*, *CIE xyY* and *CIE L\*a\*b\**. The values of the warning scale can be defined in the *Advanced Settings*.



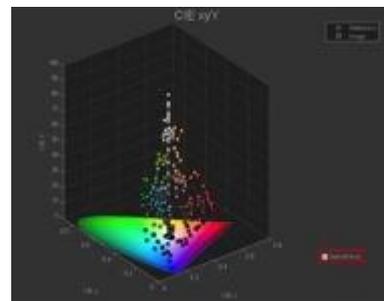
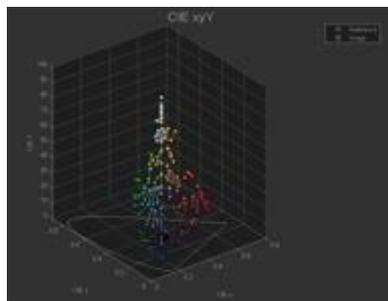
Visual Comparison



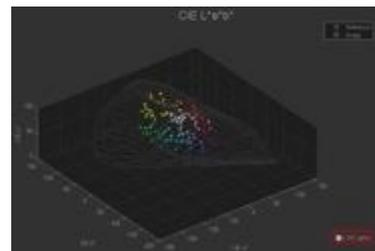
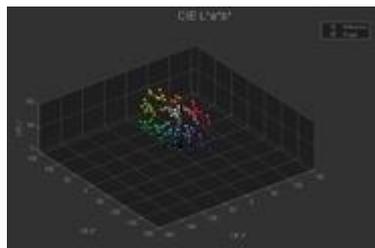
Numeric Results



3D Bars



CIE xyY: The color patches of the image (square) and the reference (circle) are displayed in the CIE xyY colorspace, where x and y are the chromaticity coordinates and Y the luminance. If the checkbox "Spectral locus" is enabled the CIE 1931 color space chromaticity diagram is also shown.



CIE L\*a\*b\*: The color patches of the image (square) and the reference (circle) are displayed in the CIE L\*a\*b\*. L\* is the luminance ( $L^* = 0$  yields black and  $L^* = 100$  indicates diffuse white), a\* describes the position between red/magenta and green (negative values indicate green while positive values indicate magenta), b\* describes the position between yellow and blue (b\*, negative values indicate blue and positive values indicate yellow). If the checkbox "L\*a\*b\* gamut" is enabled the L\*a\*b\* gamut is also shown.

## Offset correction (for delta E, L, C and H)

This selection is available for the CIE difference values. Choose between the original value (org) or corrected values (corrL, corrC, corrLC). For further explanations refer to chapter 8.4.1 Settings.



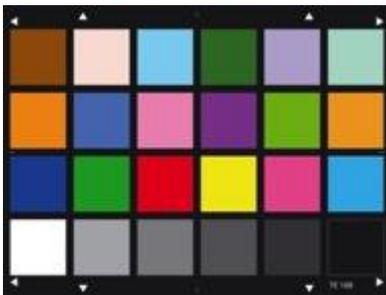
### Viewing Conditions (for VN)

This dropdown menu enables switching between the three defined viewing condition sets. For changing the presets of the viewing conditions check chapter 5.5.8.

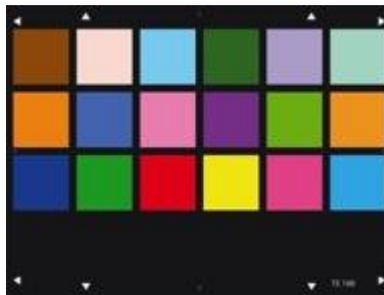
#### 8.4.3. Numerical results

All values are reported for the whole chart („All“) and for patch-groups („Color“, „Neutral“, „Skin“, ...) which are defined in the .cref file. Examples of patch-groups:

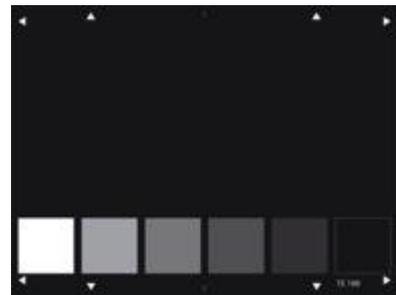
#### ColorChecker



ColorChecker „All“

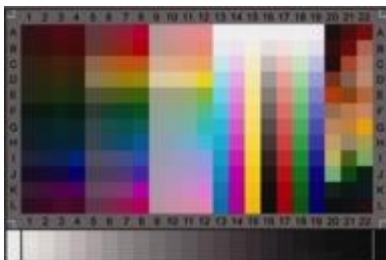


ColorChecker „Color“

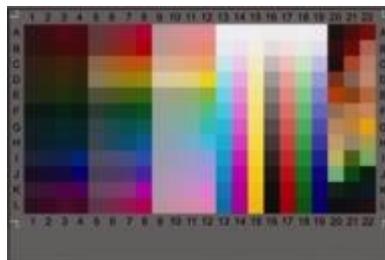


ColorChecker „Neutral“

#### IT8



IT8 „All“



IT8 „Color“



IT8 „Neutral“

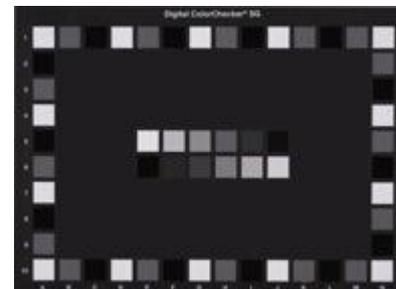
#### ColorChecker SG



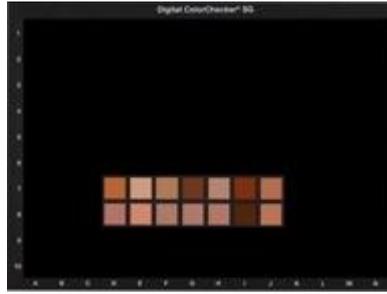
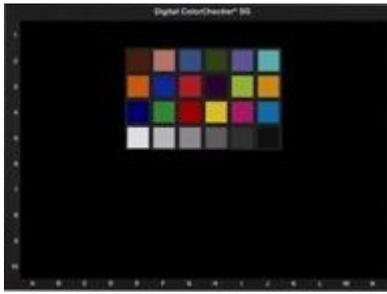
ColorChecker SG „All“



ColorChecker SG „Color“



ColorChecker SG „Neutral“



ColorChecker SG „CC – ColorChecker“

ColorChecker SG „Skin“

The numerical results report the values for Delta E, L, C and H and the visual noise (VN) for the three viewing condition sets defined in the settings. Delta E, L, C, H are stated as *mean* and *maximum* value.

**Delta E:** Color distance, a Delta E of one should be visible for a trained person

**Delta L:** Luminance in polar coordinate CIE LCh color space

**Delta C:** Chrominance in polar coordinate CIE LCh color space

**Delta H:** Hue (colortone) in polar coordinate CIE LCh color space

**L(level):** The average over all patches of L\* of the reference and of the image data is calculated. This is used to calculate the „L(level)“, the average offset of L\* between image and reference. 100% means reference and image data have the same average value.

**C(level):** The average over all patches of C\* of the reference and of the image data is calculated. This is used to calculate the „C(level)“, the average offset of C\* between image and reference. 100% means reference and image data have the same average value.

**ΔE(co. L):** The offset L(level) over all patches is subtracted from the individual patch, providing a metric for the offset corrected values. ΔE\_corrL provides the luminance error which is corrected with the average offset of the luminance (L\*).

**ΔE(co. C):** The offset C(level) over all patches is subtracted from the individual patch, providing a metric for the offset corrected values. ΔE\_corrC provides the color error which is corrected with the average offset of the saturation (C\*).

**ΔE(co. LC):** The offsets L(level) and C(level) over all patches are subtracted from the individual patch, providing a metric for the offset corrected values. ΔE\_corrLC provides the luminance and color error which is corrected with the average offset of the luminance (L\*) and saturation (C\*).

**VN Set 1:** Default: Distance to display 0.5 m, fixed resolution of 96 dpi

**VN Set 2:** Default: Fixed picture height of 100 mm, viewing distance calculated depending on image diagonal

**VN Set 3:** Default: Fixed picture height of 400 mm, viewing distance calculated depending on image diagonal

**Profile:** Prints the profile defined in the meta data of the image

	All	Neutral	Color
ΔE(mean)	5.6	3.3	6.4
ΔL(mean)	-0.6	-2.5	0.0
ΔC(mean)	0.4	0.7	0.3
ΔH(mean)	0.0	-1.2	0.4
ΔE(max)	11.9	8.2	11.9
ΔL(max)	-8.0	-8.0	-5.8
ΔC(max)	11.7	1.8	11.7
ΔH(max)	8.7	-1.9	8.7
L(level)	98.9	95.9	100.0
C(level)	101.1	142.4	100.7
ΔE(co. L)	5.7	4.3	6.4
ΔE(co. C)	5.6	3.1	6.4
ΔE(co. LC)	5.7	4.2	6.4
VN Set 1	-	-	-
VN Set 2	-	-	-
VN Set 3	-	-	-
Profile	sRGB...		



## 8.5. RESOLUTION

The resolution module enables you to measure the resolution of a digital camera system. Depending on the used test chart you get the SFR (spatial frequency response) of Siemens stars, of edges and information about reproduction of low contrast fine details using patches showing noise.



“Resolution” tab

The charts have to be illuminated homogeneously, the camera should be fixed on a tripod to minimize motion blur. Be aware that a lot of different settings in the camera influence the resolution (e.g. compression, sharpness enhancement, iso-speed). Set them carefully.

### 8.5.1. Settings

Before starting analysis of the resolution charts you have to define some settings.

## SETTINGS

### Analyze

Depending on the chosen chart layout you can select the structure(s), which shall be part of the calculation.

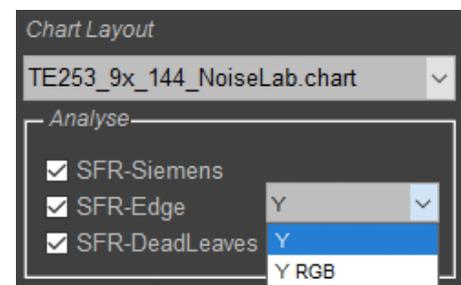
**SFR-Siemens:** Spatial frequency response of the Siemens star(s). The aim is to get a system MTF.

**SFR-Edge:** Spatial frequency response resulting from analysis of an edge

**Dead Leaves:** Spacial frequency response of the analysis of Dead Leaves pattern or of noise patches (TE253: gaussian noise:  $\sigma = 1/4$ ,  $\sigma = 1/8$ ,  $\sigma = 1/16$ ,  $\sigma = 1/2$ ) to determine information about texture loss

**Y:** Analysis of luminance values

**Y RGB:** Analysis of luminance and RGB values



### Chart is centered (only available for TE253\_single, TE280 and QA-62)

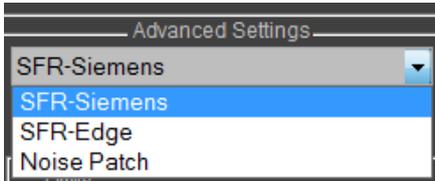
Enable „Centered“ if the subchart you want to analyze is in the image center. If enabled, the search region can be reduced, which speeds up the detection process (if the detection is set to „Automatic Mode“). If disabled, the software tries to locate a chart with the specified height in the entire image.



The default specified chart height can be changed in the Meta menu, *Chart Height* (refer to chapter 5.2.2 Image Properties).

### ADVANCED SETTINGS SFR-SIEMENS

The advanced settings change depending on the selection of the test pattern in the dropdown menu. If two or more patterns shall be analyzed you need to go through all used pattern-settings.

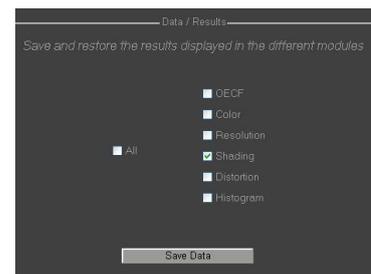


### Reduce Shading

In case of strong shading you have the opportunity to use a shading correction based on the shading measurement. Using this method produces better results.

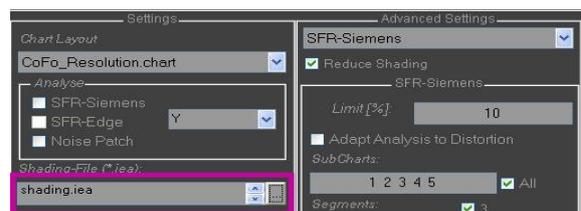


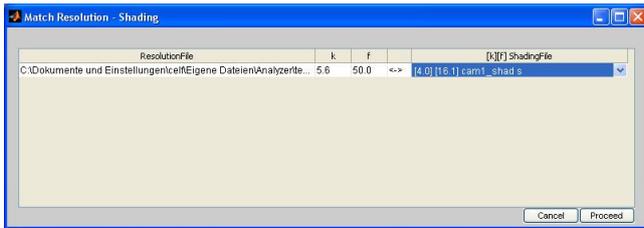
Make a shading calculation of one or more images in the Shading module and export the results as .iea file by using the Export/Import menu.



Export/Import menu: save shading results

Import the saved shading data and resolution is calculated with shading correction.





After starting the analysis a window appears that shows the files of the resolution file list with information about fstop (k) and focal length (f). Use the dropdown selection on the right of each file to match the resolution file with its corresponding shading file and press „Proceed“.

### Limits

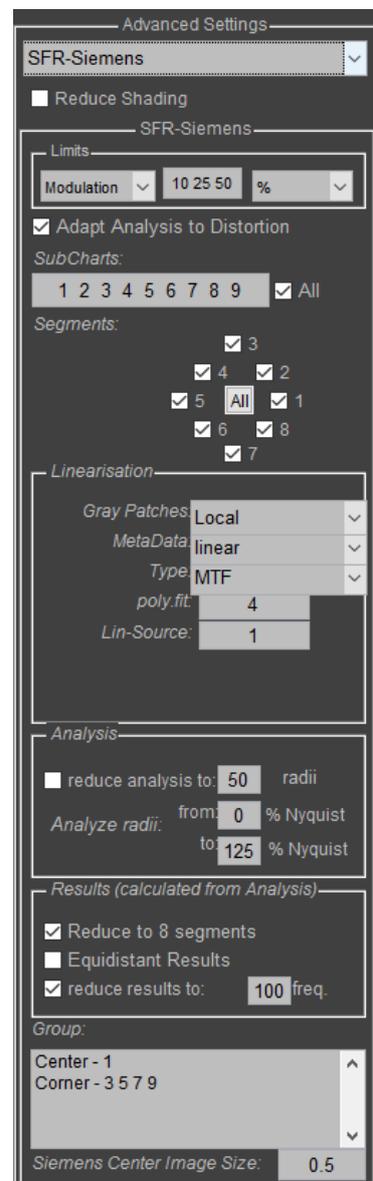
iQ-Analyzer calculates either a limiting resolution from the MTF data, which is the frequency that leads to a modulation as specified or determines the modulation according to the specified frequency. iQ-Analyzer does a linear interpolation to determine the frequency or modulation respectively.

**Modulation:** Insert modulation in percent. Separate multiple values by space. Common values are 10 (MTF10, “limiting resolution”) and 50 (MTF50). The result is the frequency derived from the SFR data based on these modulations. E.g. „50“ equals a MTF50 value which is the frequency at 50% modulation. Default values are „10 25 50“.

**Frequency:** Insert frequency in LP/PH, LP/Pix or LP/mm. Separate multiple values by space. iQ-Analyzer calculates the modulation according to the defined frequency.

### Adapt Analysis to Distortion

If the checkbox is marked, the analysis can be adapted to the distortion of the chart; the image is unchanged. iQ-Analyzer can detect and correct the influence of distortion. Disable to accelerate the calculation. Recommended is to activate „Adapt Analysis to Distortion“. If activated, iQ-Analyzer multiplies the radii with a measured correction factor, so it ensures that the analysis is done on the right position in the image.





## SubCharts

Select the subcharts (stars) you would like to analyze. If „All“ is enabled, all subcharts are listed and analyzed. Select the segments you would like to analyze. If „All“ is enabled, all eight segments are part of calculation.

## Linearization

Most cameras for photography use have a non-linear response to luminance in the scene. This is called gamma function and tries to adjust the image to the human eyes reception of light. To analyze an image, this function should be inverted, so called “linearized”. This is done by reading the gray patches in the chart, creating an OECF (Opto Electronic Conversion Function) and inverting this function.

*Gray Patches:* Define how the OECF is created (depending on the chart layout not all of the options are available):

Local use the corresponding gray patches in each subchart.

Global use one set of gray patches for complete image (define the set in „Lin-Source“)

Profil uses the OECF, defined in the profile, for linearization. By using the Meta menu a profile can be defined.

None deactivates linearization for calculation.

Other uses set of gray patches in the structure, specified in „Other-Structure“.

OECF enables an additional menu to load results of an OECF analysis performed in the OECF modul (.txt) or use the result of a currently available OECF measurement in the OECF modul.

*MetaData:* Linear assume gray patches to be linear.

\*.den Files are files that contain optical densities of each patch. Density reference files can be edited by using the *Luminance and Density data* editor of the OECF modul.

*Type:* Defines the target function. The linearization of the image data is an important step for the MTF/SFR measurement.

For the SFR\_Siemens method, it is even more important compared to SFR\_Edge. As the Siemens star in the different test charts (TE253, TE268, TE42, etc.) cannot provide very low spatial frequencies, the linearization is also used to normalize the modulation transfer to 1 for the spacial frequency of 0.

MTF forces all values in the image towards zero by the minimum value (the black patch to become „0“) by subtracting the black value of the measure OECF. So the minimum in the input image is set to zero in the linearized output image. The maximum in the input image is set to the maximum signal level, so the result is 0 to  $I_{max}-I_{min}$ .



$I_{min}$  = minimum of input image  
 $I_{max}$  = maximum of input image

Normalized (since iQ-Analyzer version 6): Using this setting, the image data is linearized using the gray patches, but the black offset is not corrected (different to “MTF” setting). As this would lead to different MTF values depending on the exposure of the image, the resulting MTF is normalized to a reference modulation. The reference modulation is calculated based on the black and the white patches used for the linearization.

This method shows only minor differences to the “MTF” setting when using a full-contrast siemens star (like the TE253 or TE268), but has advantages using low-contrast siemens stars. In this case an potential undershoot (sharpening) is represented in a better way.

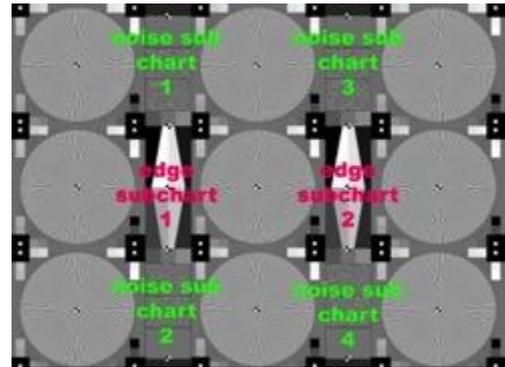
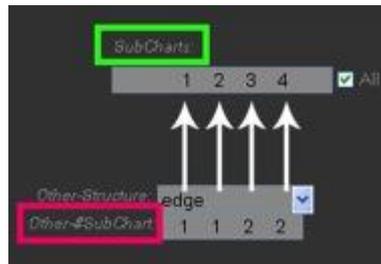
*poly.fit.:* The degree of polynomial fit for linearization can be adjusted; default: 4.

*Lin-Source:* Not always available, depends on the chart layout and the options available for *Gray Patches*. If „Global“ (see *Gray Patches*) is selected, *Lin-Source* defines which subchart is used as source for linearization.

*Other-Structure:* Not always available, depends on the chart layout and the options available for *Gray Patches*. Select the patches for linearization if you have chosen „*Gray Patches: Other*“. The number of the subchart is set in „*Other-#Subchart*“.  
siemens uses the 14 gray patches around a siemens star.  
edge uses the additional gray patches 0.4, 0.5, 0.6 of an edge structure.  
noise uses the gray patches of the noise structure. Note that not every noise structure contains gray patches. In this case you have to choose *siemens* or *edge*.

*Other-#Subchart:* Not always available, depends on the chart layout and the options available for *Gray Patches*. Choose which subcharts of the selected patches („*Other-Structure*“) is used for linearization.

Example: The four noise subcharts (1 2 3 4) use the patches of edge subcharts for linearization. Noise subchart 1 uses edge subchart 1, noise subchart 2 uses edge subchart 1, noise subchart 3 uses edge subchart 2, noise subchart 4 uses edge subchart 2.



## Analysis

*Reduce analysis to \_\_\_ radii:* If you enable this option, analysis only uses a defined number of radii to determine the MTF. This can save calculation time but might affect the accuracy of the MTF and resulting values (MTF10, MTF50, ...).

*Analyze radii from \_\_\_ % Nyquist to \_\_\_ % Nyquist:* You can select in which range of radii the iQ-Analyzer calculates the modulation. The values are given as a percentage of the Nyquist frequency. So if the Nyquist frequency is 1000 LP/PH and you set the values „from 50% to 125%“, iQ-Analyzer will analyze the radii that equals frequencies from 500 LP/PH to 1250 LP/PH. If you want iQ-Analyzer to analyze the radii starting from the border of the stars, set the first value to „0“. Default range is from 0% to 125% of Nyquist.

## Results (calculated from Analysis)

*Reduce to 8 segments:* iQ-Analyzer calculates the MTF for 24 segments of each star. If you select the checkbox, the average of three segments will be written to the result txt file.

*Equidistant Results:* If reduction is enabled, the frequencies in the output are equidistant.

*reduce result to \_\_\_ freq.:* The results are reduced to the specified number of frequencies. It is useful for working with Excel spreadsheets.

## Group

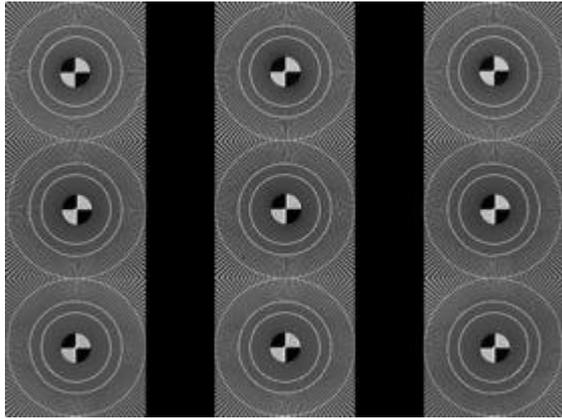
Assign subcharts to groups, which will be displayed in the graphical results. Default groups (Center, TopBottom, Left, Right, Corner) can be edited to personal uses. Expected formatting:

`<name>-<number subchart 1> <number subchart 2> ... <number subchart x>`

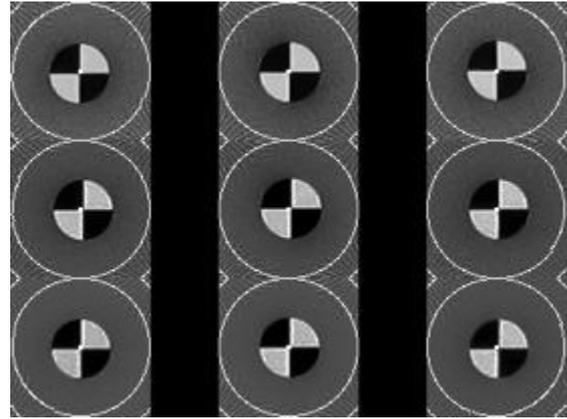
Note: the numbers of the subchart need to be divided by a space or comma.

## Siemens Center Image Size

In the resolution module – analyzing the modulated Siemens star – an image named „CenterImage“ is saved, which shows the center(s) of the Siemens star(s). You can define the size of the center image relatively to Nyquist. E.g. „0.5“ equals an image which shows the star from its center to 50% Nyquist.



Center Image Size 0.5



Center Image Size 1



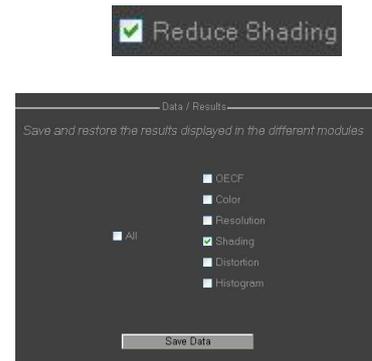
## ADVANCED SETTINGS SFR-EDGE

### Reduce Shading

In case of strong shading you have the opportunity to use a shading correction based on the shading measurement. Using this method produces better results.

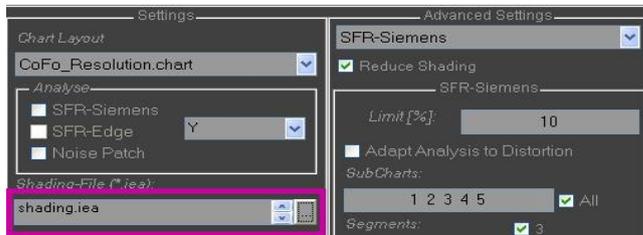


Make a shading calculation of one or more images in the Shading module and export the results as .iea file by using the Export/Import menu.



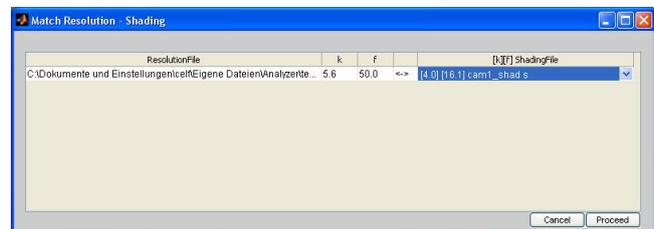
Export/Import menu: save shading results

Import the saved shading data and resolution is calculated with shading correction.



Select shading data

After starting the analysis a window appears that shows the files of the resolution file list with information about fstop (k) and focal length (f). Use the dropdown selection on the right of each file to match the resolution file with its corresponding shading file and press „Proceed“.



### Limits

iQ-Analyzer calculates either a limiting resolution from the MTF data, which is the frequency that leads to a modulation as specified or determines the modulation according to the specified frequency. iQ-Analyzer does a linear interpolation to determine the frequency or modulation respectively.

#### Modulation:

Insert modulation in percent. Separate multiple values by space. Common values are 10 (MTF10, “limiting resolution”) and 50 (MTF50). The result is the frequency derived from the SFR data based on these modulations. E.g. „50“ equals a MTF50 value which is the frequency at 50% modulation. Default values are „10 25 50“.



**Frequency:** Insert frequency in LP/PH, LP/Pix or LP/mm. Separate multiple values by space. iQ-Analyzer calculates the modulation according to the defined frequency.

### SubCharts

Select the subcharts (edges) you would like to analyze. If „All“ is enabled, all subcharts are listed and analyzed.

### OversamplingFactor

Degree of oversampling the slanted edge; default: 4.

### Max. Frequency

The highest frequency, that shall be reported in unit „LP/pix“; default: 0.6 (Nyquist frequency: 0.5).

### Frequencies

Number of frequencies in the output; default: 100.

### Edge Profile Size

Number of sampling points to describe the edge profile. Size in pixel is the quotient of *Profile Size* and *OversamplingFactor*; default: 50 (+/- 5 pixel around edge).

### Edge Profile Source

**Original data:** Data for sharpening is calculated based on the original image data as found in the image file.

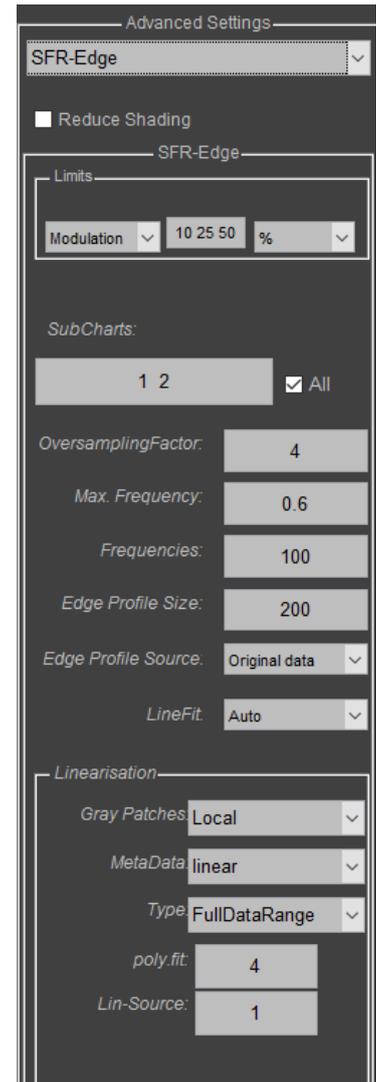
**Linearized data:** Data for sharpening is calculated based on the linearized image data as the SFR is calculated on.

### LineFit

One important step of the algorithm is to fit a line along the edge. This can be a straight line (linear, ISO 12233 standard) or a bended line (polynomial: auto, 2<sup>nd</sup>, 3<sup>rd</sup> or 4<sup>th</sup> degree)). The aim is to reduce the fit error which is shown in the numerical results.

### Linearization

Most cameras for photography have a non-linear response to luminance in the scene. This is called gamma function and tries to adjust the image to the human perception of light. To analyze an image, this function should be inverted, also called the image shall be “linearized”. This is done by reading the





gray patches in the chart, creating an OECF (Opto Electronic Conversion Function) and inverting this function.

**Gray Patches:** Define how the OECF is created (depending on the chart layout not all of the options are available):  
Local use the corresponding gray patches in each subchart.  
Global use one set of gray patches for complete image (define the set in „Lin-Source“)  
Profil uses the OECF, defined in the profile, for linearization. By using the Meta menu a profile can be defined.  
None deactivates linearization for calculation.  
Other uses set of gray patches in the structure, specified in „Other-Structure“.  
OECF enables an additional menu to load results of an OECF analysis performed in the OECF modul (.txt) or use the result of a currently available OECF measurement in the OECF modul.

**MetaData:** Linear assume gray patches to be linear.  
\*.den Files are files that contain optical densities of each patch. Density reference files can be edited by using the *Luminance and Density data* editor of the OECF modul.

**Type:** Defines the target function.  
MTF forced all values in the image towards zero by the minimum value. So the minimum in the input image is set to zero in the linearized output image. The maximum in the input image is set to the maximum signal level, so the result is 0 to  $I_{max}-I_{min}$ .

$I_{min}$  = minimum of input image

$I_{max}$  = maximum of input image

FullDataRange uses the full bitdepth of an image.

$$Lin_{min} = 0, Lin_{max} = 2^{bitdepth} - 1 = 255 \text{ (for 8 bit).}$$

$Lin_{min}$  = minimum of the linearized image

$Lin_{max}$  = aximum of the linearized image

FullImageRange depicted the minimum and maximum digital value of the input image as minimum resp. maximum digital value in the output image.

$$I_{min} \text{ to } I_{max}, Lin_{min} = I_{min}, Lin_{max} = I_{max}.$$

**poly.fit.:** The degree of polynomial fit for linearization can be adjusted; default: 4.

**Lin-Source:** Not always available, depends on the chart layout and the options available for Gray Patches. If „Global“ (see Gray Patches) is selected, Lin-Source defines which subchart is used as source for linearization.



**Other-Structure:** Not always available, depends on the chart layout and the options available for *Gray Patches*. Select the patches for linearization if you have chosen „*Gray Patches: Other*“. The number of the subchart is set in „*Other-#Subchart*“.

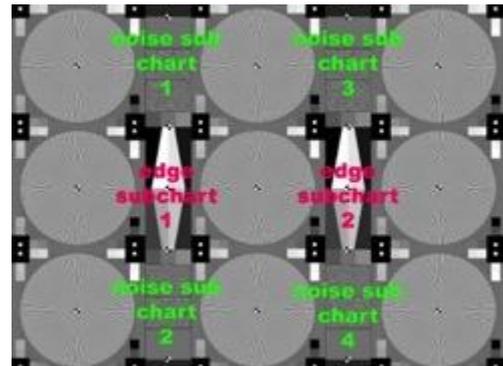
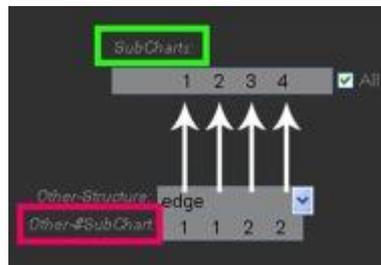
siemens uses the 14 gray patches around a siemens star.

edge uses the additional gray patches 0.4, 0.5, 0.6 of an edge structure.

noise uses the gray patches of the noise structure. Note that not every noise patches contain gray patches. In this case you have to choose *siemens* or *edge*.

**Other-#Subchart:** Not always available, depends on the chart layout and the options available for *Gray Patches*. Choose which subcharts of the selected patches („*Other-Structure*“) is used for linearization.

Example: The four noise subcharts (1 2 3 4) uses the patches of edge subcharts for linearization. Noise subchart **1** uses edge subchart **1**, noise subchart **2** uses edge subchart **1**, noise subchart **3** uses edge subchart **2**, noise subchart **4** uses edge subchart **2**.





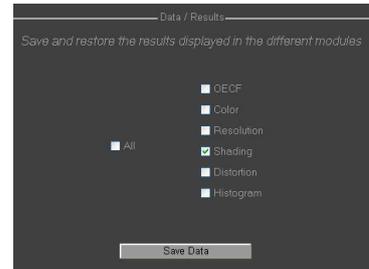
## ADVANCED SETTINGS SFR DEAD LEAVES

### Reduce Shading

In case of strong shading you have the opportunity to use a shading correction based on the shading measurement. Using this method produces better results.

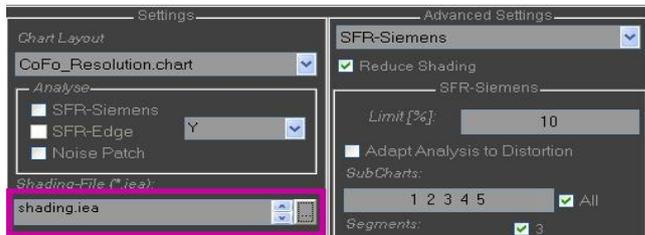


Make a shading calculation one or more images in the Shading module and export the results as .iea file by using the Export/Import menu.



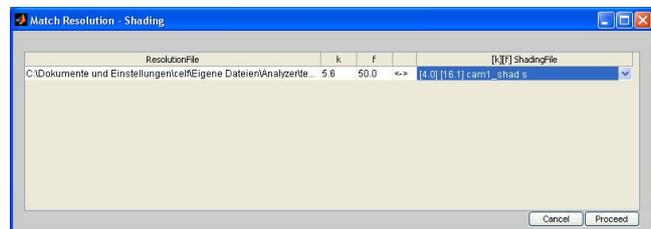
Export/Import menu: save shading results

Import the saved shading data and resolution is calculated with shading correction.



Select shading data

After starting the Analysis a window appears that shows the files of the resolution file list with information about fstop (k) and focal length (f). Use the dropdown selection on the right of each file to match the resolution file with its corresponding shading file and press „Proceed“.





## Limits

iQ-Analyzer calculates either a limiting resolution from the MTF data, which is the frequency that leads to a modulation as specified or determines the modulation according to the specified frequency. iQ-Analyzer does a linear interpolation to determine the frequency or modulation respectively.

**Modulation:** Insert modulation in percent. Separate multiple values by space. Common values are 10 (MTF10, "limiting resolution") and 50 (MTF50). The result is the frequency derived from the SFR data based on these modulation. E.g. „50“ equals a MTF50 value which is the frequency at 50% modulation.

Default values are „10 25 50“.

**Frequency:** Insert frequency in LP/PH, LP/Pix or LP/mm. Separate multiple values by space. iQ-Analyzer calculates the modulation according to the defined frequency.

## SubChart

Select the subcharts (Dead Leaves or noise patch) you would like to analyze. If "All" is enabled, all possible patches are part of calculation.

## Linearization

Most cameras for photography use have a non-linear response to luminance in the scene. This is called gamma function and tries to adjust the image to the human perception of light. To analyze an image, this function should be inverted, also called the image shall be "linearized". This is done by reading the gray patches in the chart, creating an OECF (Opto Electronic Conversion Function) and inverting this function.

**Gray Patches:** Define how the OECF is created (depending on the chart layout not all of the options are available):

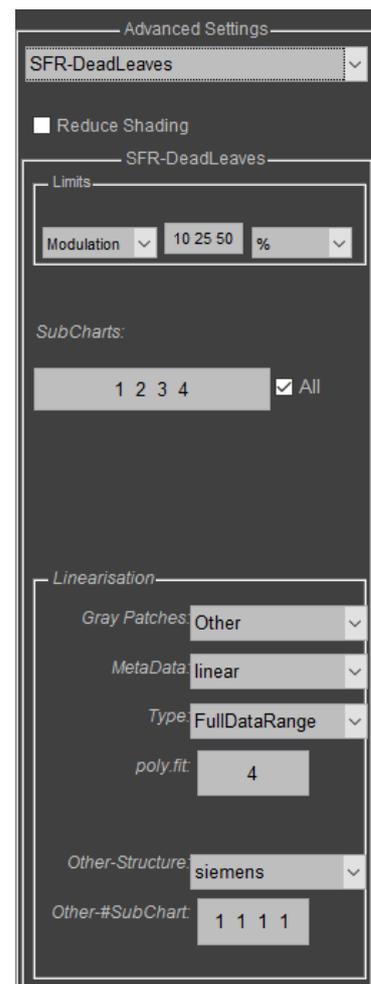
Local use the corresponding gray patches in each subchart.

Global use one set of gray patches for complete image (define the set in „Lin-Source“)

Profil uses the OECF, defined in the profile, for linearization. By using the Meta menu a profile can be defined.

None deactivates linearization for calculation.

Other uses set of gray patches in the structure, specified in „Other-Structure“.





OECF enables an additional menu to load results of an OECF analysis performed in the OECF modul (.txt) or use the result of a currently available OECF measurement in the OECF modul.

**MetaData:** Linear assume gray patches to be linear.  
\*.den files are files with includes patch densities for linearization.

**Type:** Defines the target function.  
MTF forces all values in the image towards zero by the minimum value. So the minimum in the input image is set to zero in the linearized output image. The maximum in the input image is set to the maximum signal level, so the result is 0 to  $I_{max}-I_{min}$ .

$I_{min}$  = minimum of input image

$I_{max}$  = maximum of input image

FullDataRange uses the full bitdepth of an image.

$$Lin_{min} = 0, Lin_{max} = 2^{bitdepth} - 1 = 255 \text{ (for 8 bit).}$$

$Lin_{min}$  = minimum of the linearized image

$Lin_{max}$  = maximum of the linearized image

FullImageRange depicted the minimum and maximum digital value of the input image as minimum resp. maximum digital value in the output image.

$$I_{min} \text{ to } I_{max}, Lin_{min} = I_{min}, Lin_{max} = I_{max}.$$

**poly.fit.:** The degree of polynomial fit for linearization can be adjusted; default: 4.

**Lin-Source:** Not always available, depends on the chart layout and the options available for *Gray Patches*. If „Global“ (see *Gray Patches*) is selected, *Lin-Source* defines which subchart is used as source for linearization.

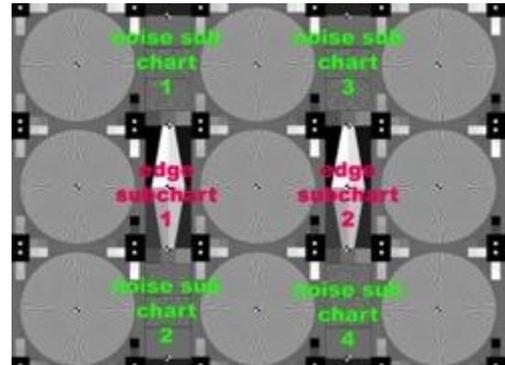
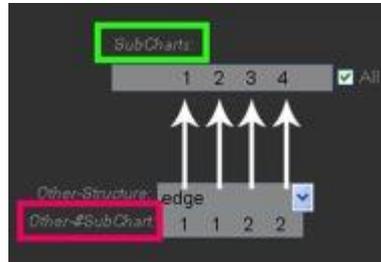
**Other-Structure:** Not always available, depends on the chart layout and the options available for *Gray Patches*. Select the patches for linearization if you have chosen „*Gray Patches: Other*“. The number of the subchart is set in „*Other-#Subchart*“.  
siemens uses the 14 gray patches around a siemens star.  
edge uses the additional gray patches 0.4, 0.5, 0.6 of an edge structure.  
noise uses the gray patches of the noise structure. Note that not every noise patches contain gray patches. In this case you have to choose *siemens* or *edge*.

**Other-#Subchart:** Not always available, depends on the chart layout and the options available for *Gray Patches*. Choose which subcharts of the selected patches („*Other-Structure*“) is used for linearization.

Example: The four noise subcharts (1 2 3 4) uses the patches of edge subcharts for linearization. Noise subchart 1 uses edge subchart 1, noise subchart 2 uses



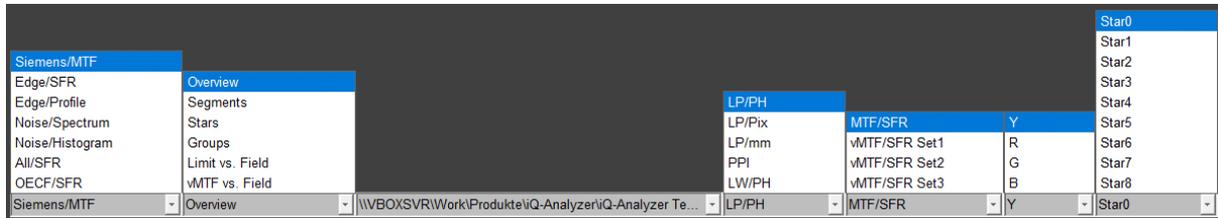
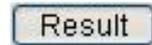
edge subchart 1, noise subchart 3 uses edge subchart 2, noise subchart 4 uses edge subchart 2.





## 8.5.2. Graphical presentation

By pressing the „Result“ button the results are displayed in the right screen. The view could be changed using the options in the below dropdown menus.



depending on the the diplayed result (selected with the first dropdown menu) the further menus offer different views

### Specify parameter

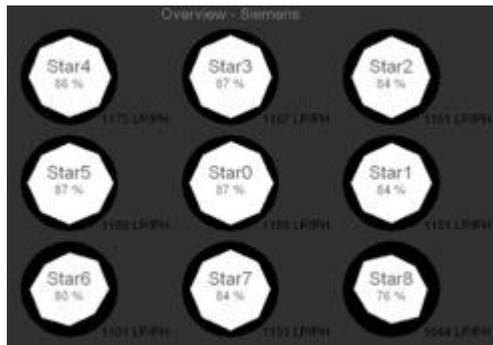
By using the left dropdown menu below the graphs you can choose the displayed result, based on the pattern available in the used chart and dependend on the activated analysis in the settings:

- Siemens/MTF:* Includes different views of the MTF curve calculated with a sinusoidal Siemens star
- Edge/SFR:* Includes different views of the SFR curve calculated with a slanted edge
- Edge/Profile:* Includes different views of the edge profile
- Noise/Spectrum:* Plot of the spectrum of noise and Dead Leaves calculations
- Noise/Histogram:* Plot of the histogram of noise and Dead Leaves calculations
- OEFC/SFR:* If a linearization is chosen the calculated OEFC is displayed in this view.

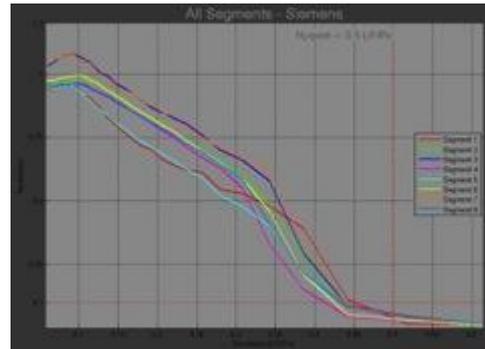
### Plot selection

The second dropdown contains several presentations corresponding to the selected parameter.

- Siemens/MTF Overview:* Overview of the SFR calculation of the siemens stars. The black circle represent the Nyquist frequency, the white polygon the limiting resolution of each segment. So the more the polygon covers the black circle the better. The percentage value in the center gives the ratio between Nyquist frequency and the limiting resolution of the average of all segments. Alignment issues of charts or devices can be seen easily in this illustration.



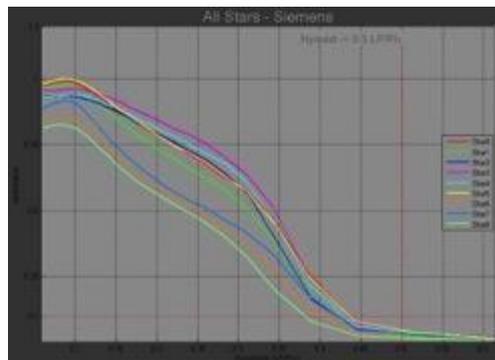
Siemens/MTF Overview



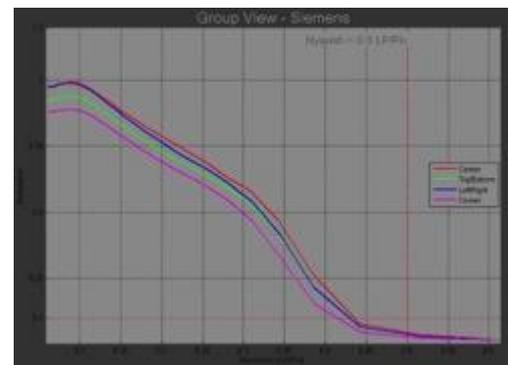
Siemens/MTF Segments (LP/Pix)

**Siemens/MTF Segments:** The MTF is plotted for each segment (average of all stars). The y-axis represents the modulation, the x-axis the spatial frequency. The red dashed vertical line indicates the Nyquist frequency. The red dashed horizontal line indicates the modulation which is specified as limiting resolution in the Advanced Settings. This illustration is useful to see differences in horizontal and vertical resolution.

**Siemens/MTF Stars:** This plot shows the MTF of each siemens star. The MTF is calculated as the average of all segments. In the table you find the limiting resolutions of each star (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”). The red dashed vertical line indicates the Nyquist frequency. The red dashed horizontal line indicates the modulation which is specified as limiting resolution in the Advanced Settings.



Siemens/MTF Stars (LP/Pix)



Group (LP/PIX)

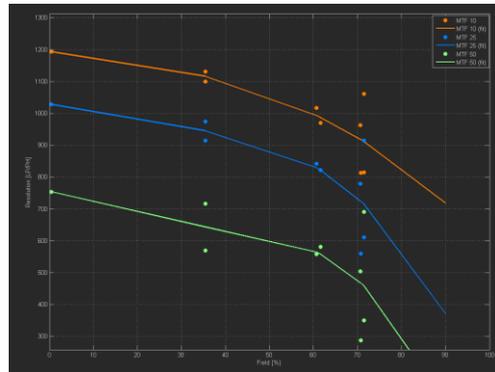
**Siemens/MTF Group:** This is a more compact illustration of the MTF of the siemens stars. In the “Advanced Settings” for SFR Siemens you can combine stars to groups. iQ-Analyzer calculates the average for each group. In the table you find the limiting resolutions of each group (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”). The red dashed vertical line indicates the Nyquist frequency. The red dashed horizontal



line indicates the modulation which is specified as limiting resolution in the Advanced Settings.

*Siemens/Limit vs. Field:*

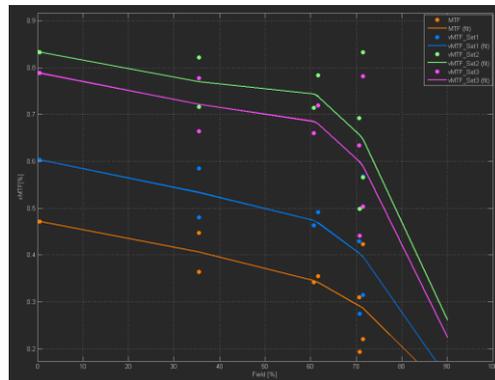
This graph plots the MTF10, MTF25 and MTF50 against the height in the image field. Image field position “0” means the image center. The graph shows the individual result (dot) and a line fitted in the measurement results.



Edge/SFR Mean/Sub (LP/Pix)

*Siemens/vMTF vs. Field:*

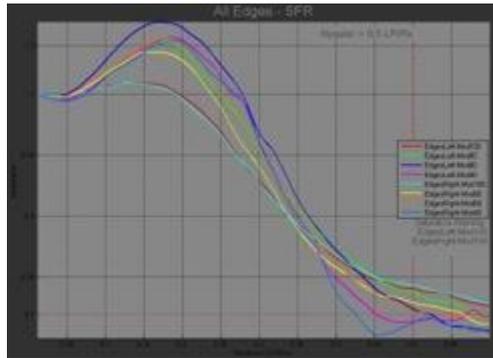
This graph plots the MTF and the three visual MTFs (vMTF) against the height in the image field. Image field position “0” means the image center. The graph shows the individual result (dot) and a line fitted in the measurement results.



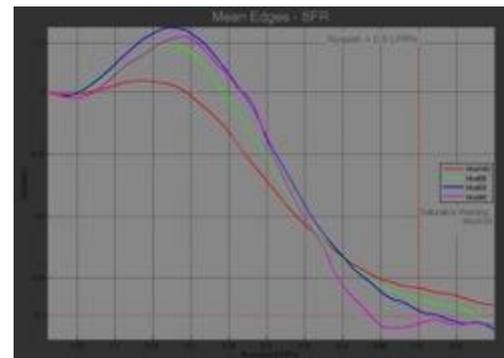
Edge/SFR Mean/Sub (LP/Pix)

*Edge/SFR All:*

This plot shows the MTF of each edge with the different modulations (e.g. for TE253 NoiseLab left and right edges with modulations of 100%, 80%, 60%, 40%).



Edge/SFR All



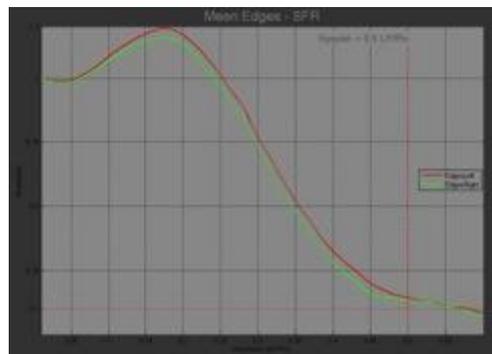
Edge/SFR Mean/Edge (LP/Pix)

*Edge/SFR Mean/Sub:* This is a more compact illustration of the SFR Edge. iQ-Analyzer calculates the average of all edges in one subchart.

E.g. for TE253 NoiseLab, iQ-Analyzer calculates each the average of the left and the right edges.

EdgesLeft = mean (edges left 100, edges left 80, edges left 60, edges left 40)

EdgesRight = mean (edges right 100, edges right 80, edges right 60, edges right 40)



Edge/SFR Mean/Sub (LP/Pix)

The modulation of these two averages are shown. In the table you see the limiting resolutions of mean edges left and right. The limiting value can be set in the “Advanced Settings” for “SFR Siemens”.

*Edge/SFR Mean/Edge:* This is a more compact illustration of the SFR Edge. iQ-Analyzer calculates the average of all edges with the same name over subchart.

E.g. for TE253 NoiseLab iQ-Analyzer calculates each the average of the left and the right edges with same modulation.

Mod100 = mean (edges left 100, edges right 100)

Mod 80 = mean (edges left 80, edges right 80)



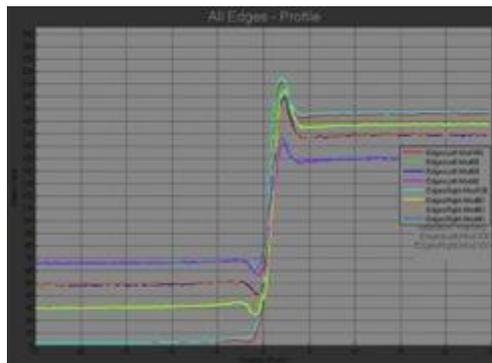
Mod 60 = mean (edges left 60, edges right 60)

Mod 40 = mean (edges left 40, edges right 40)

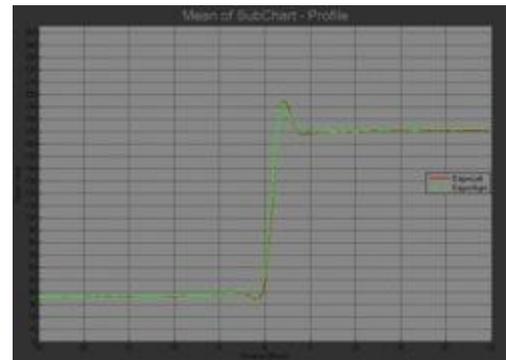
The modulation of these four averages are shown. In the table you find the limiting resolutions of mean edges left and right. The limiting value can be set in the “Advanced Settings” for “SFR Siemens”.

*Edge/Profile All:*

The illustration represents the edge profile intensity of all edges with different modulations (e.g. eight edges in TE253 NoiseLab). In the table you see the edge width.



Edge/Profile All



Edge/Profile Mean/Sub

*Edge/Profile Mean/Sub:*

The illustration represents the edge profile intensity of the average of all edges in one subchart. (e.g. the average of the left edges and the average of the right edges in TE253 NoiseLab).

*Edge/Profile Mean/Edge:*

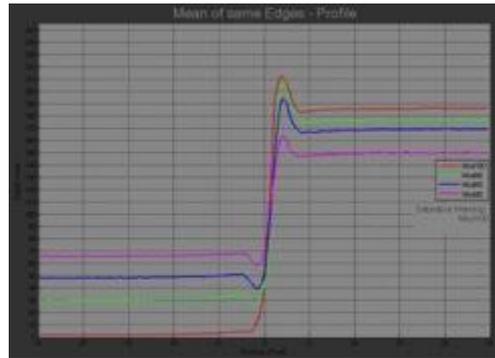
This is a more compact illustration of the edge profile. iQ-Analyzer calculates the average of all edges with the same name over subchart. E.g. for TE253 iQ-Analyzer calculates each, the average of the left and the right edges with same modulation.

Mod100 = mean (edges left 100, edges right 100)

Mod80 = mean (edges left 80, edges right 80)

Mod60 = mean (edges left 60, edges right 60)

Mod40 = mean (edges left 40, edges right 40)

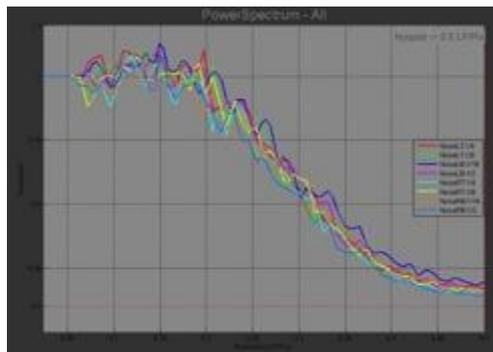


Edge/Profile Mean Edge

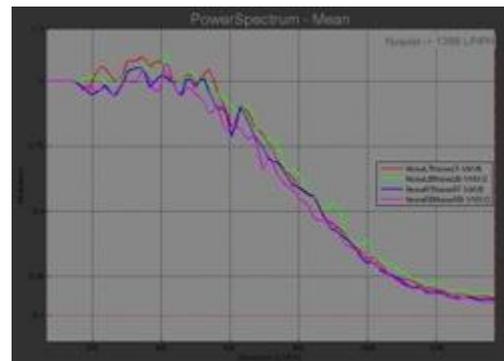
The edge profile intensities of these four averages are shown. In the table you find the edge width.

*Noise/Spectrum All:*

This plot shows the MTF of the different noise patches. In the table you find the limiting resolution of each noise patch (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”).



Noise/Spectrum All



Noise/Spectrum Mean

*Noise/Spectrum Mean/All:* All available

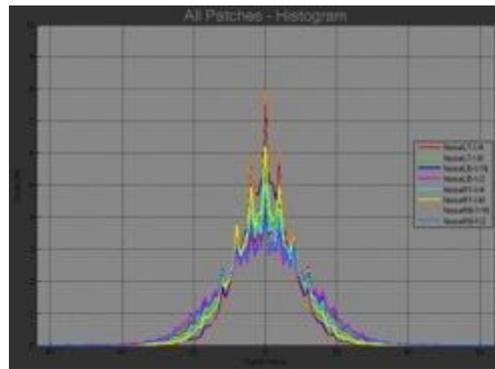
*Noise/Spectrum Gaussian:* Measured on gaussian white noise as found in e.g. TE253

*Noise/Spectrum DeadLeaves:* Measured on dead leaves pattern

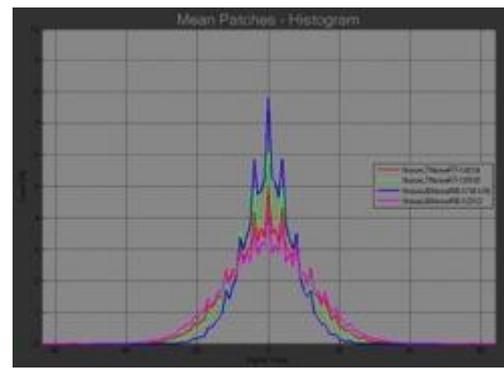
*Noise/Spectrum Reference:* Measured on reference patches for dead leaves analysis

*Noise/Histogram All:*

This illustration shows the derivative of the four different noise patches on every side (left top 1/4, left top 1/8, left bottom 1/16, left bottom 1/2, right top 1/4, right top 1/8, right bottom 1/16, right bottom 1/2).



Noise/Histogram All



Noise/Histogram Mean

**Noise/Histogram Mean:** This is a more compact illustration of the noise histogram. iQ-Analyzer calculates each, the average of the left and the right edges with same noise.

**All/SFR Overview:** The most important SFR functions in one plot. Useful for e.g. TE42 results, in which multiple SFRs from one image are available. The larger the difference, the more image enhancement and other algorithms have been applied.

**All/SFR All:** All measured SFR from one target in one plot

**OECF/SFR:** The image data needs to be linearized before calculation. This is controlled in the advanced settings in the “linearization” box. In extreme cases (very strong vignetting, geometric distortion or noise) the measured OECF for the linearization might be influenced. The graph shows the measured OECF as used for calculating needed linearization.

### Available files

By using the third drop down menu you can choose between result representation of the particular image file (file path is shown) and representation of the average („Average“) if „Average“ (Settings) in the output properties is selected.

### Dimensional unit

The fourth dropdown menu switches between different dimensions of the x-axis.

You can choose between linepairs per picture height (LP/PH), linepairs per pixel (LP/Pix) , linepairs per mm (LP/mm) and pixel per inch (PPI). The information about resolution in PPI is obtained from EXIF data or the default value made in the settings.



### Visual MTF

The next dropdown menu enables switching between the representation of the original MTF/SFR and the visual MTF. The visual MTF factors are defined in the three viewing condition sets in the *General Settings* tab.

### Luma/Chroma Channels

The last dropdown enables you to switch between R, G, B and the luminance values Y.

### 8.5.3. Numerical results

The displayed numerical results vary depending on the selection made in the dropdown menus.

Note: An exclamation point in the numerical results indicates, that the frequency cannot be calculated and is set to Nyquist. In the text output these frequencies are signed with a minus.

### SIEMENS / MTF

SFR-Siemens uses a Siemens star with a harmonic function. The aim is to get a MTF (modulation transfer function). The MTF describes the loss of modulation depending on the spatial frequency ( $f_{\text{spatial}}$ ).

The numerical results contain information about the MTF for each segment or summarized as different averages (stars and groups).

Note: In the table you find the limiting resolutions of each star (the limiting value can be set in the advanced settings for „SFR Siemens“).

#### MTF10/25/50

The limiting modulations for which the resolution in LP/PH (line pair per picture hight), LP/Pix (line pair per pixel) and PPI (pixel per inch) is shown (default: 10, 25 and 50) can be specified in the advanced menu.

#### MTF [%]

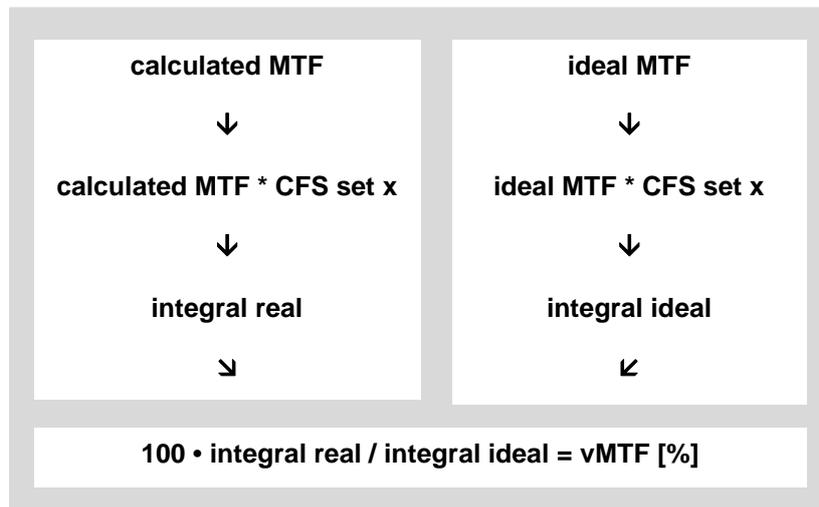
The percentual value describes the actual area beyond the curve in comparison to the ideal area.

	Star0	Star1	Star2
MTF10	1325	1138	1240
MTF25	1156	974	1091
MTF50	1005	807	927
MTF [%]	74.0	55.1	64.3
vMTF	90.2	73.0	82.0
vMTF	115.1	103.7	106.5
vMTF	110.8	98.1	102.8
	Star3	Star4	Star5
MTF10	1236	1152	1070
MTF25	1088	1007	948
MTF50	928	816	783
MTF [%]	67.6	53.1	51.8
vMTF	86.1	69.3	69.5
vMTF	111.7	93.5	100.1
vMTF	108.0	89.8	94.6
	Star6	Star7	Star8
MTF10	1018	1164	1082
MTF25	884	1021	928
MTF50	691	856	736
MTF [%]	42.1	57.3	45.4
vMTF	57.6	74.6	61.4
vMTF	88.0	104.5	91.0
vMTF	81.8	98.7	85.0



### vMTF Set 1-3 [%]

Similar to the visual noise, which quantifies how well a human observer can recognize noise, the visual MTF implicates the three defined viewing condition sets. The calculated and the ideal MTF are multiplied with the contrast sensitivity function (CSF) which depends on the viewing condition sets for visual noise. The two integrals are divided. Multiplied with 100 you get the visual MTF (vMTF) in percent.



### EDGE / SFR

The SFR measurement is done on edges with different modulations (e. g. TE253 between 100% to 40%). The assumption is, that the denoising algorithms have to detect edges to distinguish between information and noise in the image signal. Using the different modulations, it can be checked if the edge is treated differently.

The table with text results contains information about the Edge/SFR for the edges (selectable by using the second dropdown menu). The limiting modulations for which the resolution is shown (default: 10, 25 and 50) can be specified in the Advanced Menu. Also the visual MTF for the three viewing conditions sets is displayed.

### Edge/SFR Mean/Edge

iQ-Analyzer calculates the average of all edges with the same modulation over the whole chart.

Example: TE253 NoiseLab, calculation of the four averages of the left and the right edges with same modulation. The numerical results contain the limiting resolutions for each average.

*Mod100* = mean (edges left 100, edges right 100)

*Mod80* = mean (edges left 80, edges right 80)

*Mod60* = mean (edges left 60, edges right 60)

*Mod40* = mean (edges left 40, edges right 40)



### Edge/SFR Mean/Sub

iQ-Analyzer calculates the average of all edges in one subchart. The numerical results contain limiting resolutions for each subchart.

Example: TE253 NoiseLab, calculation of the average of the left and the right edges.

*EdgesLeft* = mean (edges left 100, edges left 80, edges left 60, edges left 40)

*EdgesRight* = mean (edges right 100, edges right 80, edges right 60, edges right 40)

### MTF10/25/50

The limiting modulations for which the resolution in LP/PH (line pair per picture height), LP/Pix (line pair per pixel) and PPI (pixel per inch) is shown (default: 10, 25 and 50) can be specified in the advanced menu.

	Mod100	Mod50	Mod60
MTF10	1601	1380	1409
MTF25	900	1054	1076
MTF50	729	803	853
MTF [%]	36.2	37.6	40.8
vMTF	53.2	56.3	60.5
vMTF	83.8	82.4	86.4
vMTF	77.3	77.6	82.0
FitError	4.3	4.1	4.2
Misreg	0.07	0.25	0.19
Misreg	0.19	0.20	0.18
Over/U	7/100	5/10	4/7
Modula	85%	65%	48%

### MTF [%]

The percentual value describes the actual area beyond the curve in comparison to the ideal area.

### vMTF Set 1-3 [%]

Similar to the visual noise, which quantifies how well a human observer can recognize noise, the visual MTF implicates the three defined viewing condition sets. The calculated and the ideal MTF are multiplied with the contrast sensitivity function (CSF) which depends on the viewing condition sets for visual noise. The two integrals are divided. Multiplied with 100 you get the visual MTF (vMTF) in percent.

### FitError

For the SFR-Edge approach, an ideal line along the edges has to be determined. The FitError shows how well this line could be fitted into the real image data. The lower the value, the better the fit.

### Misreg.RG

The Misregistration of the red channel in an RGB image to the green channel. This value is calculated based on the edge spread functions in the different channels and is reported in pixel. A value of two means, that the red channel is off by two pixel to the green channel, orthogonal to the evaluated edge.

### Misreg.BG

Same as Misreg.RG, but for the green and blue channel.

### Over/Under

Calculated based on the edge profile, these values report the found undershoot and overshoot, which is an effect of sharpening. It is defined as  $(\max\_over - \max) / \max * 100$  for overshoot (corresponding for undershoot).

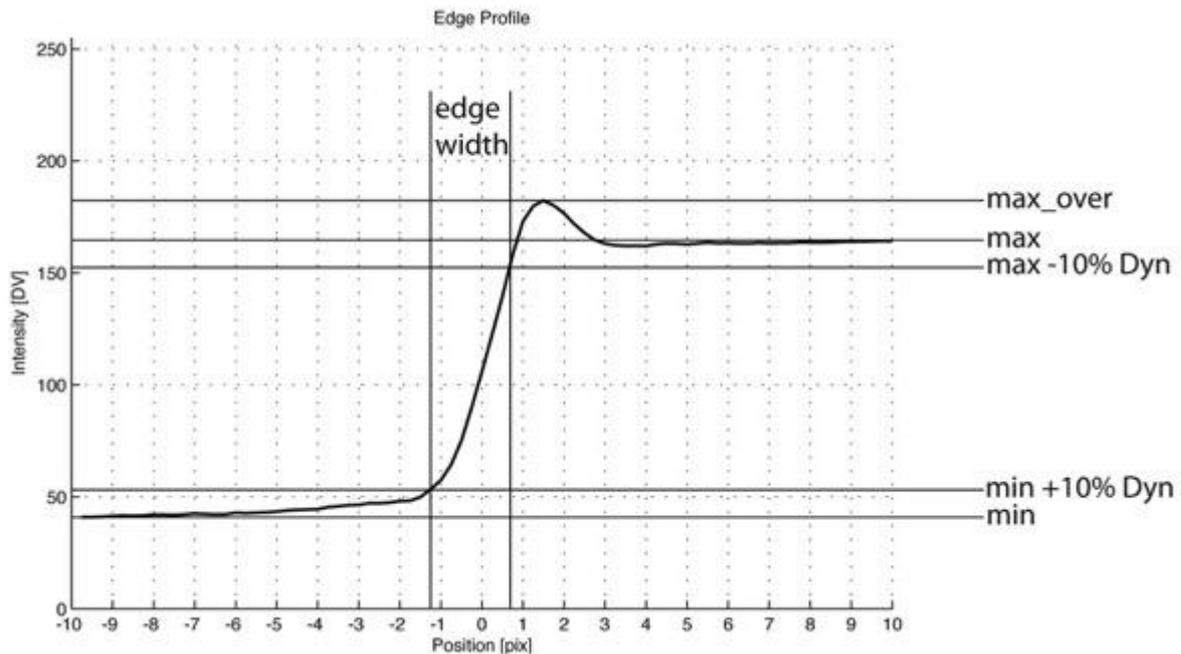


## Modulation

The measured modulation in the linearized image. This value should be close not necessary equal to the modulation of the target.

## EDGE / PROFILE

The edge profile gives information about over and undershoot and edge width. The pixels are binned by their distance to the fitted edge description.



The y-axis is the intensity in digital values (for a 8 bit image from 0 to 255). The x-axis represents the position related to the edge. So value 0 is the position of the maximum of the first derivative of the edge profile. For example a value of 4 means 4 pixel right of the edge, therefore a value of -4 means 4 pixel left to the edge. Left always represents the low intensity, right the high intensity side of the edge.

The reported value is the 10% edge width. The edge width is the distance in pixel between two points in edge profile. First point is reached by an increase of the intensity by 10%Dyn, second point is reached at max - 10%Dyn, with

$$10\% Dyn = 0.1 \cdot (\max - \min)$$



### Edge/Profile All

The illustration represents the edge profile intensity of all edges with different modulations (e.g. eight edges in TE253 NoiseLab). In the table you find the edge width.

### Edge/Profile Mean/Sub

The illustration represents the edge profile intensity of the average of all edges in one subchart (e.g. the average of the left edges and the average of the right edges in TE253 NoiseLab).

### Edge/Profile Mean/Edge

This is a more compact illustration of the edge profile. iQ-Analyzer calculates the average of all edges with the same name over subchart. E.g. for TE253 NoiseLab iQ-Analyzer calculates each the average of the left and the right edges with same modulation.

	Mod100	Mod80	Mod60
Edge-V	2.08	2.07	1.91
FitErro	4.3	4.1	4.2
Misreg	0.07	0.25	0.19
Misreg	0.19	0.20	0.18
Over/U	7/100	5/10	4/7
Modula	85%	65%	48%
	Mod40		
Edge-V	2.17		
FitErro	4.1		
Misreg	0.12		
Misreg	0.10		
Over/U	2/0		
Modula	34%		

*Mod100* = mean (edges left 100, edges right 100)

*Mod80* = mean (edges left 80, edges right 80)

*Mod60* = mean (edges left 60, edges right 60)

*Mod40* = mean (edges left 40, edges right 40)

The edge profile intensities of these four averages are shown. In the table you find the edge width.

### NOISE/SPECTRUM

This plot shows the SFR of the different noise patches. In the table you find the limiting resolution of each noise patch (the limiting value can be set in the “Advanced Settings” for “SFR-DeadLeaves”).

For Information about the numerical results please refer to chapter 8.5.3.

### C\*

C\*WP is the result of calculating the mean value of C\* on the Dead Leaves pattern and correcting it by using C\* of a white reference (white patch of gray scale). The value is an indication on the loss of saturation if high frequencies (small details) are present. This value is stated only in the text and XML files (“C\*WP(mean)”).

### NOISE/HISTOGRAM

The histogram of noise holds different information about the noise characteristics. But the histogram would change for different mean values of the noisy image signal, so the first derivative is used. The target is a gaussian white noise, so all digital values appear in the image with a

	NoiseL-14	NoiseL-15	NoiseL-116
Kurtos	0.23	0.34	0.52
	NoiseR-12	NoiseR-14	NoiseR-15
Kurtos	0.19	0.22	0.35
	NoiseR-116	NoiseR-12	
Kurtos	0.68	0.31	



probability defined by the gaussian distribution around the mean value. In the processed image, the mean value becomes zero, as the first derivative of a flat image is zero.

To describe the shape of the distribution, the excess kurtosis is calculated. The value becomes 0 for a normal distribution and is increased for leptokurtic distributions. The kurtosis is calculated as the fourth moment divided by the square of the second moment of the distribution. The second moment is the variance.

$$kurt = \frac{m_4}{m_2^2} - 3 = \frac{m_4}{\sigma^4} - 3 = \left( \frac{1}{n} \sum_{i=1}^n \left( \frac{x_i - \mu}{\sigma} \right)^4 \right) - 3$$

The kurtosis is calculated for the four different noise patches ( $\sigma = 1/4$ ,  $\sigma = 1/8$ ,  $\sigma = 1/16$ ,  $\sigma = 1/2$ ). The y-axis represents the relative count of digital values in the x-axis. The count of the values is expressed in percentage, so a count of 10% means, that one tenth of all pixel have this value.

### **Noise/Histogram All**

This illustration shows the derivative of the four different noise patches on every side (left top 1/4, left top 1/8, left bottom 1/16, left bottom 1/2, right top 1/4, right top 1/8, right bottom 1/16, right bottom 1/2).

### **Noise/Histogram Mean**

This is a more compact illustration of the noise histogram. iQ-Analyzer calculates each the average of the left and the right edges with same noise.



## 8.6. SHADING

Shading describes the loss of intensity from the center of an image to the corner. Shading includes the vignetting of the lens and all other effects that may cause a loss of light. iQ-Analyzer uses the OECF to calculate the shading in f-stops.



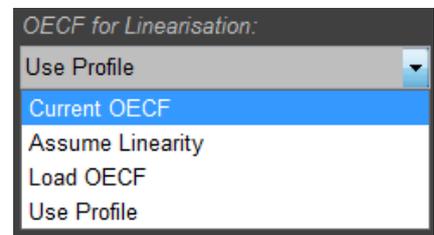
"Shading" tab

### 8.6.1. Settings

Before starting analysis of shading charts you have to define some settings.

#### SETTINGS

iQ-Analyzer needs OECF data (tone curve of the system under test) for linearization to provide a meaningful measure of the intensity shading.

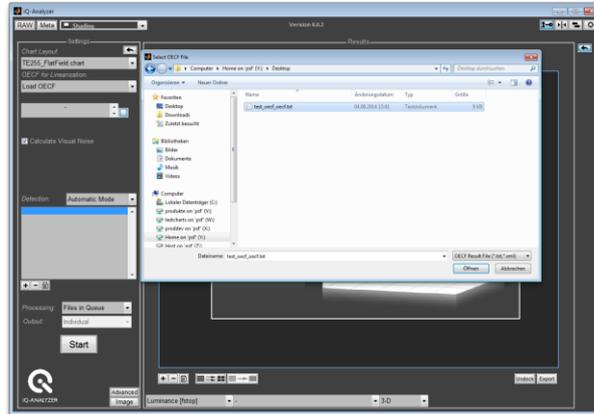


dropdown menu for OECF data

*Current OECF:* iQ-Analyzer uses OECF data that is actually calculated and displayed in the OECF module.

*Assume Linearity:* Shading can be calculated without a related OECF file. If no OECF is specified, a linear OECF can be used. If you use the linear OECF and your device does not work linear, the results for the shading calculated in f-stops will be incorrect.

*Load OECF:* If you want to use another OECF (or an idealized OECF), you can load an OECF result file from the iQ-Analyzer OECF module. Use the „...“ button and select an OECF .txt file.



by using the button you can select an OECF file

*Use Profile:*

The tone curve is extracted from the ICC Profile as specified in the „Meta“ section and used for linearization. This is much more flexible, as the OECF measurement is not needed, but also less accurate as most cameras tend not to follow exactly the tone curve of the profile.



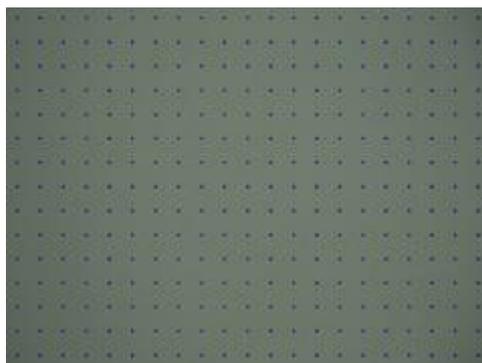
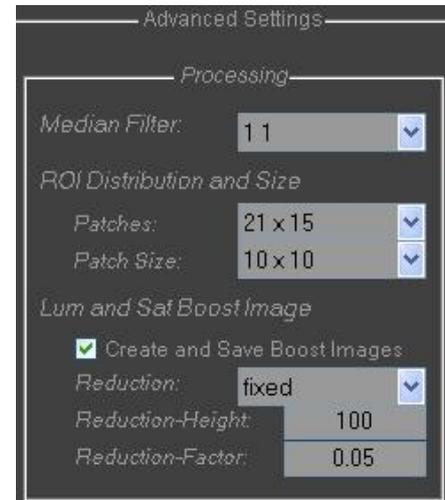
## ADVANCED SETTINGS

### Processing

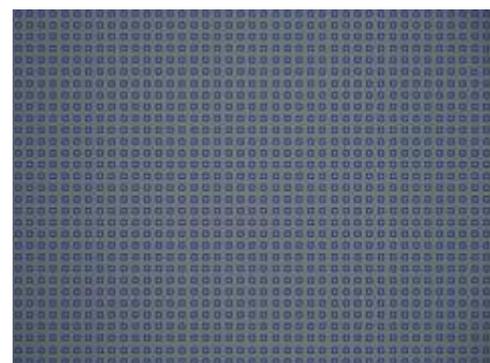
**Median Filter:** To reduce noise the image is filtered before analyzing. Define the matrix size of the median filter. 1x1 means no filtering, by using the 11x11 matrix the picture is filtered most.

**Note:** If size of median filter is not 1x1 noise measurement has no significance.

**ROI Distribution and Size:** Choose number and size of ROI patches. The higher the number and size, the exact is the shading calculation. But it also will increase calculation time.



patches 21x15, patch size 10x10



patches 41x31, patch size 30x30

**Lum and Sat Boost Image:** Adjustments to set if LumBoost and the SatBoost image are saved and specifications to create them.

**Create and Save Boost Images** enables/disables if boost images (luminance and saturation) shall be created and saved during calculation.

**Reduction** reduces the image size and though the calculating time. By using the dropdown menu you can define the reduction mode.

**Fixed** reduces the picture height to the value defined in „Reduction Height“ (picture width will be adjusted proportional), e.g. original image 2000x3000 pixel, Reduction-Height 50, reduced image 50x75 pixel.

**Relative** reduces the picture height percental to the value defined in “Reduction-Factor”, e.g. original image 2000x3000 pixel, Reduction-Factor 0.05, reduced image 100x150 pixel



## Analysis

**Normalization:** By using the dropdown menus you can specify the normalization process.

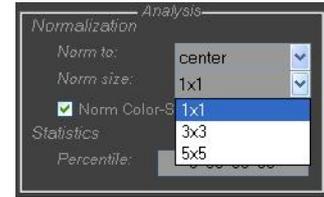
Norm to specifies the region that is used for normalization:

„*center*“ uses the center of the image for normalization (reference = center = 0).

„*maxpos*“ sets the coordinate with the maximal luminance as reference for normalization (reference = max. Luminance = 0).

Norm size sets the norm size of the area which is used for normalization, e.g. 1x1 just one patch, 3x3 average of 3 patches.

Norm Color-Shading to Mean activates that the color shading shall be normalized to mean value of image instead of to the maximum. This is according to the non-published IEEE-CPIQ standard.).



**Statistics:** The Percentile rank of a score is the percentage of scores in its frequency distribution which are lower or equal to it. Insert values for the percentiles you want to get from calculation. In the results the percentiles are displayed in digital values (DV) and f-stops.



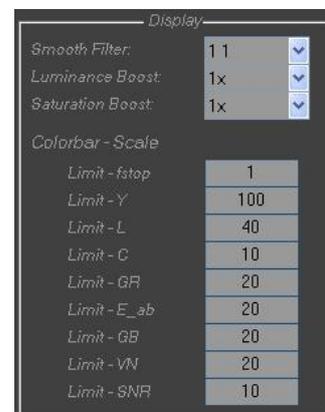
values for percentiles

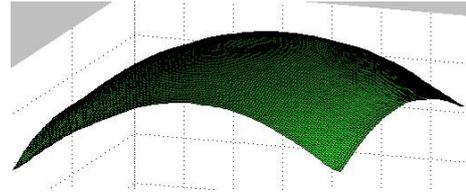
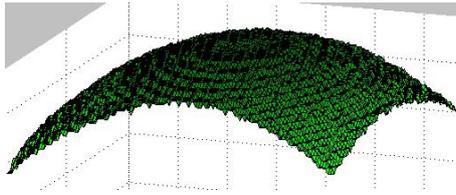
percentiles Y [DV]	18.1/-1.2/-0.2/0.4
percentiles Y [f-stop]	-0.20/-0.01/-0.00/0.00

results in digital values (DV) and f-stop

## Display

**Smooth Filter:** The graphical results can be displayed smoothed. By using the dropdown menu define the filter matrix. 1x1 means no filtering, filtering with an 11x11 matrix effects most. During the analysing process, the image is converted to the LCh colorspace (luminance, saturation, hue).





1x1 and 11 x 11 matrix

*Luminance Boost:* Define the boost for displaying luminance.

*Saturation Boost:* Define the boost for displaying saturation.



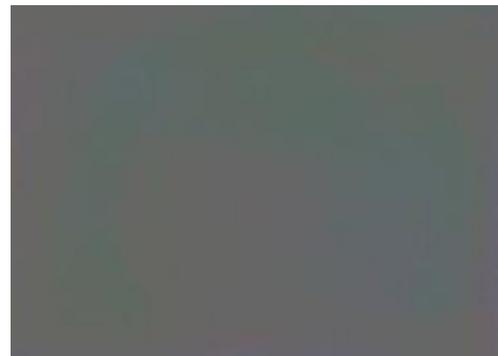
Luminance Boost 1x



Luminance Boost 5x



Saturation Boost 1x



Saturation Boost 5x



scale for luminance shading (f-stops)

**Colorbar – Scale:** By inserting values for each representation you can scale the color bar right to the graphical results.

**Limit - fstop** define the scale for the graphical representation of luminance shading in f-stops.

**Limit - Y** define the scale for the graphical representation of luminance shading.

**Limit - L** define the scale for the graphical representation of luminance shading (CIE-L).

**Limit - C** define the scale for the graphical representation of color shading (CIE-C).

**Limit - GR** define the scale for visualization of the difference between the green and red channel.

**Limit - E\_ab** define the scale for visualization of delta E\_ab.

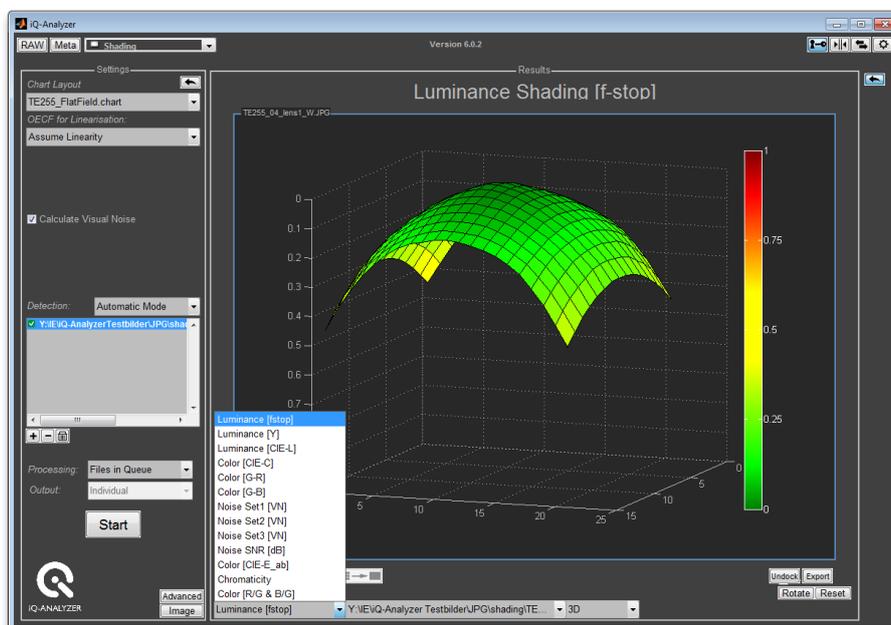
**Limit - GB** define the scale for visualization of the difference between the green and blue channel.

**Limit - VN** define the scale for visualization of the visual noise.

**Limit - SNR** define the scale for visualization of the signal to noise ratio.

## 8.6.2. Graphical presentation

The graphical results are displayed in the right screen. Below the graphical results are some dropdown menus.



settings in the left screen

results and dropdown menus in the right screen

### Specify parameter

The left one allows switching between the result plots.

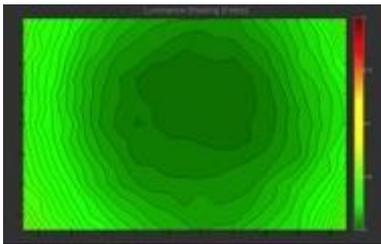


### Available files

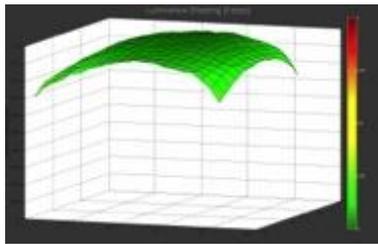
By using the third drop down menu you can choose between result representation of the particular image file (file path is shown) and representation of the average („Average“) if you have selected „Average“ in the output properties below the file list on the left side.

### Plot selection

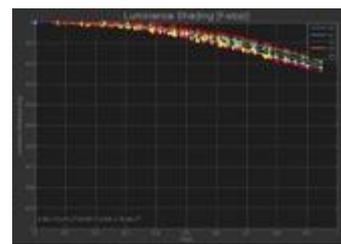
The right dropdown menu switches between 3-D, Contour plot (2-D) and Plot. When „Plot“ is selected „field“ means the picture height and the fourth-degree polynomial describes the curve „All“.



Contour



3-D



Plot

### 8.6.3. Numerical results

The numerical results are shown in the right table and exported as text file (or other as adjusted in the settings).

#### Luminance

**Shading [f-stop]:** The maximum shading of luminance in f-stops

**Shading [%]:** The maximum shading of luminance as percentage visible in the image. This value is calculated in the image data (with Y as a weighted sum of R, G and B). This value is not affected by the linearization.  $(Y_{max} - Y_{min}) / (Y_{max}) * 100$

$$Shading [%] = \frac{Y_{max} - Y_{min}}{Y_{max}} * 100$$

**CIE Δ L:** The absolute average shading of luminance (CIE L)

$$\Delta L = L_{max} - L_{min}$$

**Shading [%lin]:** The maximum shading of luminance as percentage, caused by the lens or other components. This value is calculated based on the linearized data, the luminance. When changing the linearization method this value will change accordingly.

$$Shading [%lin] = \frac{L_{max} - L_{min}}{L_{max}} * 100$$

<b>Luminance</b>	
Shading [f-stop]	0.5
Shading [%]	29.8
CIE ΔL	19.1
percentiles Y	-30.1/-1.4/-0.6/0
percentiles Y	-0.29/-0.01/-0.0
<b>Color</b>	
CIE ΔEab	4.3
CIE ΔC	6.8
ΔG-R[DV]	14.9
ΔG-B [DV]	10.0
R/G & B/G	0.97 / 0.94
<b>Noise</b>	
Δ SNR[dB]	11.1
Δ VNSet1	3.0
Δ VNSet2	1.5
Δ VNSet3	1.9



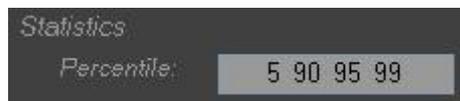
If you use the Setting "Assume linearity" (correct setting for linear or RAW image) the results of *Shading [%lin]* and *Shading [%]* is equal.

This value is calculated based on the linearized data, the luminance. When changing the linearization method this value will change accordingly.

*percentiles [DV]:* By inserting values for percentiles (in the Advanced mmenu) you get information about the luminance distribution explained in digital Values (DV) and f-stops depending on the chosen normalization.

*percentiles [f-stop]:* By inserting values for percentiles (in the Advanced mmenu) you get information about the luminance distribution explained in digital Values (DV) and f-stops depending on the chosen normalization.

Example: A percentile of 5 results in a digital value of -17.1. This means, 5% are less and 95% greater than -17.1.



define values for percentiles

percentiles Y	-18.1/-1.2/-0.2/0.4
percentiles Y	0.20/0.01/0.00/0.00

results after calculation

## Color

*CIE ΔE<sub>ab</sub>:*

CIE ΔE<sub>ab</sub> expresses the maximum color shading as maximum color difference over the image field. It is conform to the *Chrominance Non-uniformity* defined in ISO 17957:2015 and the *Color Uniformity* defined in IEEE P1858 Standard for Camera Phone Image Quality (CPIQ).

In contrast to the ΔE calculation that is used in the color module, the calculation of ΔE<sub>ab</sub> is done without luminance L\*. So you get information only about differences in colors without luminance.

$$D_c(i) = \sqrt{(a^*(i) - \bar{a}^*)^2 + (b^*(i) - \bar{b}^*)^2}$$

$$D_c = \max_i D_c(i)$$

$$\bar{a}^* = \frac{1}{n} \sum_{i=1}^n a^*(i) \quad \text{and} \quad \bar{b}^* = \frac{1}{n} \sum_{i=1}^n b^*(i)$$

*n: number of ROIs in the image*

*CIE ΔC:*

CIE ΔC expresses the maximum color shading related to a defined reference value. This reference value can either be the center of the image or the maximum saturation in the image (depending on Advanced Settings „Norm to“ and „Norm size“).

$$\Delta C(i) = \sqrt{a_n^{*2} + b_n^{*2}} - \bar{C}_{center} \quad \text{or} \quad \Delta C(i) = \sqrt{a_n^{*2} + b_n^{*2}} - \bar{C}_{maxpos}$$



$$\Delta C = \max_i \Delta C(i)$$

*n*: number of ROIs in the image

$$\overline{C}_{center} = \frac{1}{m} \sum_{i=1}^m C(i) \quad \text{or} \quad \overline{C}_{maxpos} = \frac{1}{m} \sum_{i=1}^m C(i)$$

*m*: number of ROIs defined as Norm size in the Advanced Settings

- $\Delta G-R$  [DV]:** The average difference between green and red channel, explained in digital values.
- $\Delta G-B$  [DV]:** The average difference between green and blue channel, explained in digital values.
- R/G & B/G:** The ratios R/G and B/G are calculated for each ROI. The maximum value for each ratio is stated in the table.

### Noise

- $\Delta SNR$  [dB]:** The maximum difference of SNR, explained in dB.
- $\Delta VNSet1$ :** The maximum difference of visual noise (viewing condition set 1).
- $\Delta VNSet2$ :** The maximum difference of visual noise (viewing condition set 2).
- $\Delta VNSet3$ :** The maximum difference of visual noise (viewing condition set 3).

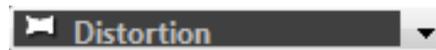
### Optical Center

- horizontal [pixel]:** To be added
- vertical [pixel]:** To be added
- distance [pixel]:** To be added
- distance [mm]:** To be added
- angle [degree]:** Angle in degrees to which the optical center is shifted (referring to the image center as zero point)



## 8.7. DISTORTION

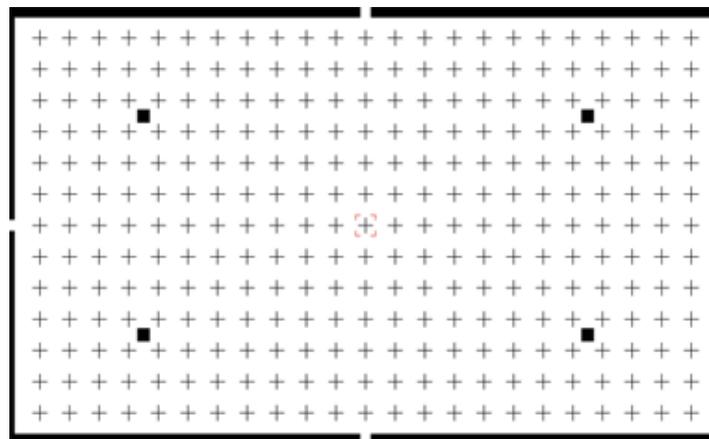
The distortion module enables you to evaluate the distortion and the lateral chromatic aberration in one step. Therefore iQ-Analyzer uses a test patterns, crosses or points, which are distributed over the complete image. The center of the crosses (points) are located with sub pixel precision for RGB. The distortion and the chromatic aberration can be calculated from these locations.



"Distortion" tab

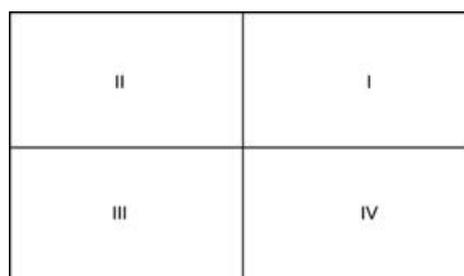
There are some requirements for the image as they could affect the results:

- make sure that the camera is not tilted in any direction
- the center cross in the chart (surrounded by markers) has to be the center cross in the image as well
- arrange the camera in such a way that the image shows the full chart height. The image aspect ratio specifies how many crosses you cover in width
- the image must show only complete crosses
- the chart should be illuminated homogeneously



TE251 – The test chart for calculation of distortion and the chromatic aberration

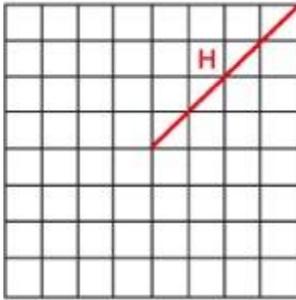
### LGD – Lens Geometric Distortion



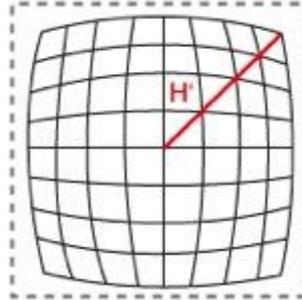
the four quadrants (Q1, Q2, Q3, Q4)



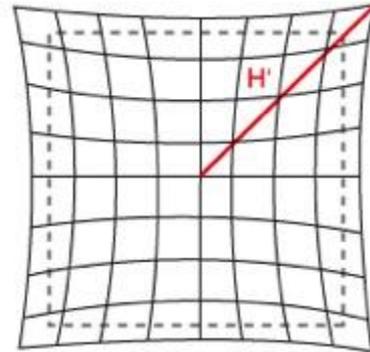
Undistorted Grid



Barrel Distortion (negative)



Pincushion Distortion (positiv)



Lens Geometric Distortion Definition

The lens geometric distortion is defined as

$$LGD = 100 \cdot \frac{(H' - H)}{H}$$

$H'$  = dot distance from center of image

$H$  = undistorted dot position

The geometric distortion for a grid position is the delta between the radial distance of the actual grid position  $H'$  and radial distance to the ideal grid position  $H$ , divided by the ideal grid position  $H$ .

$H' < H$  indicates negativ distortion (barrel distortion)

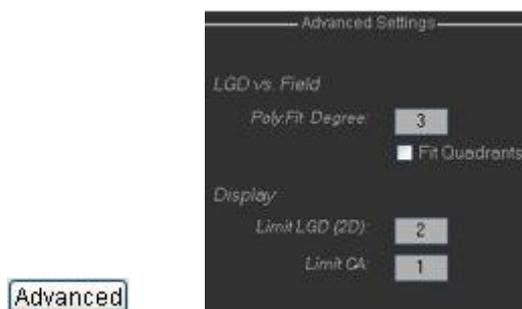
$H' > H$  indicates positive distortion (pincushion distortion)

### 8.7.1. Settings

Before starting analysis of the distortion charts you have to define some settings.

#### ADVANCED SETTINGS

By using the „Advanced“ button the Advanced menu opens.



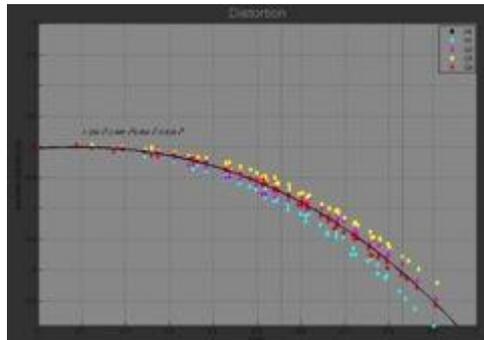
“Advanced” button and the opening Advanced menu



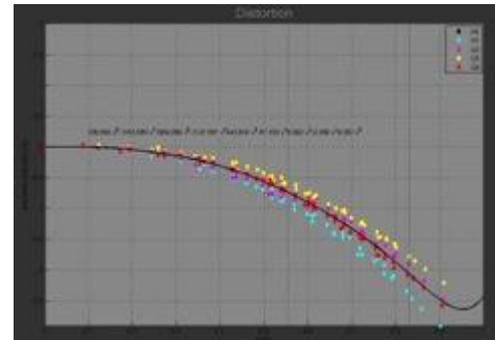
## LGD vs. Field

This adjustment affects the graphical presentation „Distortion vs. Field“ and the calculation of the value „LGD worst (fit)“.

**Poly.Fit Degree:** The „Distortion vs. Field“ plots the distortion of every cross (see graphical resolution) and calculate a line of best fit for the image. Changing the degree of the polynom adapts the line as necessary. We recommend a polynomial degree of 3 for standard distortion figures. For more complicated and/or strong distortion figures the polynomial degree might be increased. A look at the graphical presentation will show you if you choose the right degree: the line should lie smoothly between the calculated values with no excessive aberrations.

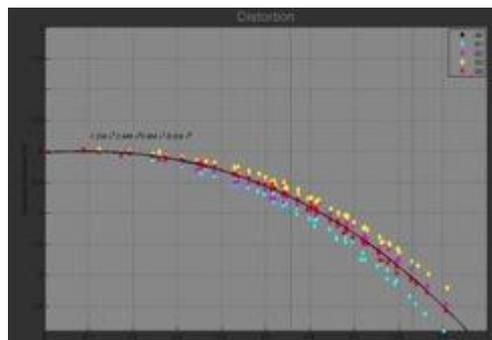


Poly.Fit Degree: 3

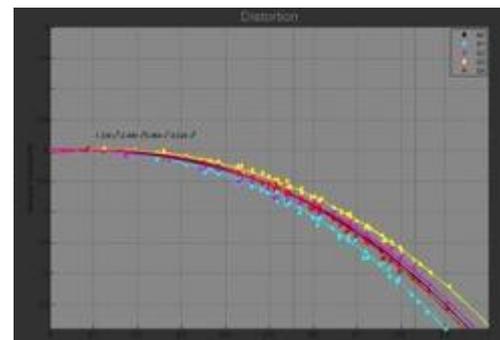


Poly.Fit Degree: 8

**Fit Quadrants:** The crosses are divided into the four quadrants of image. Activate the checkbox and the line of best fit is not only calculated for the whole image but also for each quadrant.



one line of best fit is displayed



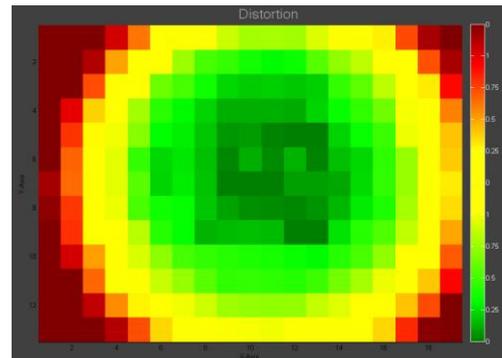
line of best fit for each quadrant



## Display

*Limit LGD (2D):* Scales the warning scale for the 2D view of distortion.

*Limit CA:* Scales the warning scale for the view of chromatic aberration.



Warning level in the 2D view of distortion

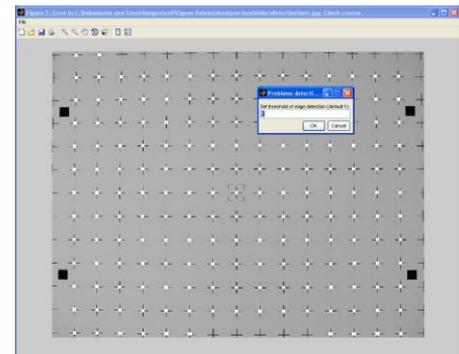
## LocalGD referenced to

*Image Height (obsolete):* In earlier versions of iQ-Analyzer (before standards availability), reference was the Image Height. Not recommended any more.

*Image Field (ISO, CPIQ):* Calculation according to ISO and CPIQ standards.

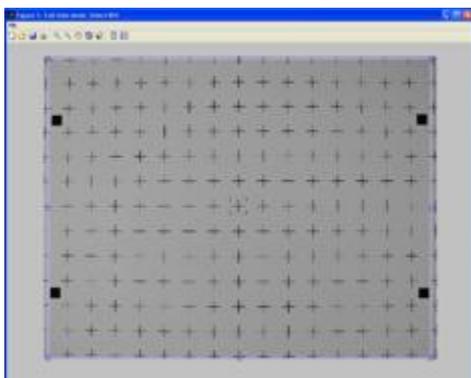
### 8.7.2. Analyzing process

If there is a problem detecting all crosses, you are directed automatically into the fail-safe mode. First you have to select another threshold for detection. Default value is "1". Set this value to a lower value (e.g. 0.5) if the image is blurred or has a great loss of sharpness to the corners. Set this value to a higher value (e.g. 3) if the image is sharpened strongly (e.g. mobile phones).

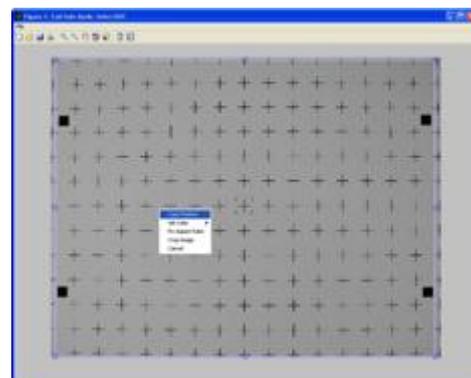


select threshold

Then select a region of interest in the image. You have to select the ROI so that you still have 13 rows of crosses. If you do happen to cut a column of crosses in the image, do not include this column into the ROI. Use the right mouse "Crop Image" or double click on the image and the analysing process starts.



select ROI

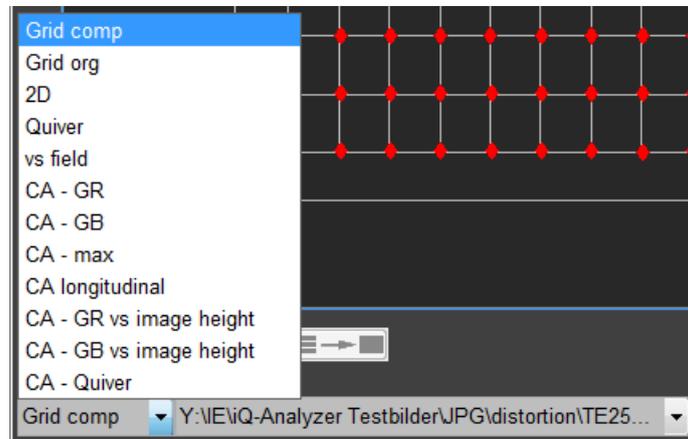


crop image and the analysing process starts



### 8.7.3. Graphical results

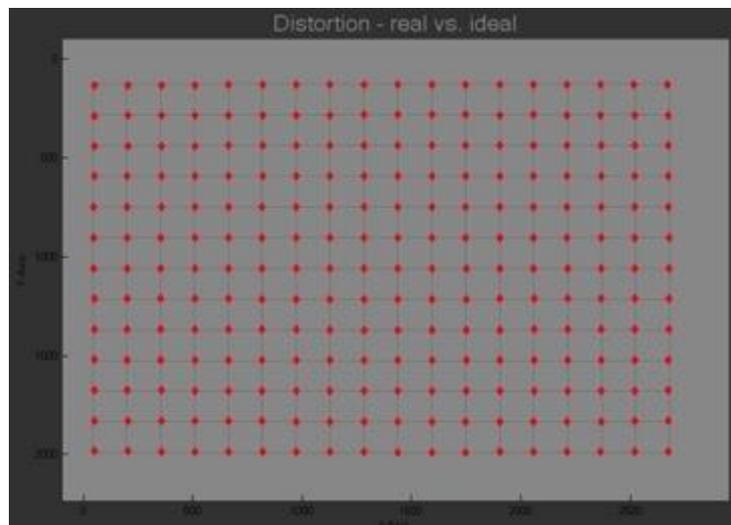
The left dropdown menu below the diagrams in the *Result View* allows you to select the graphical presentation of the results.



by using the dropdown menus you can select an image file and choose the displayed result

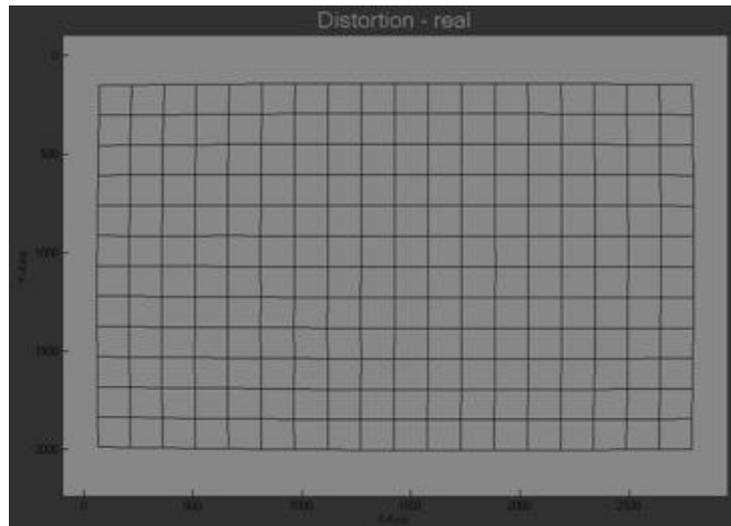
*Grid comp:*

The illustration visualizes the distortion in the image. Each dot represents a cross in the real image. The black grid represents the original image. X and Y are height and width of the image in pixel. The geometric distortion is plotted as a function of radial distance from the center of the image versus the lens geometric for each grid point.



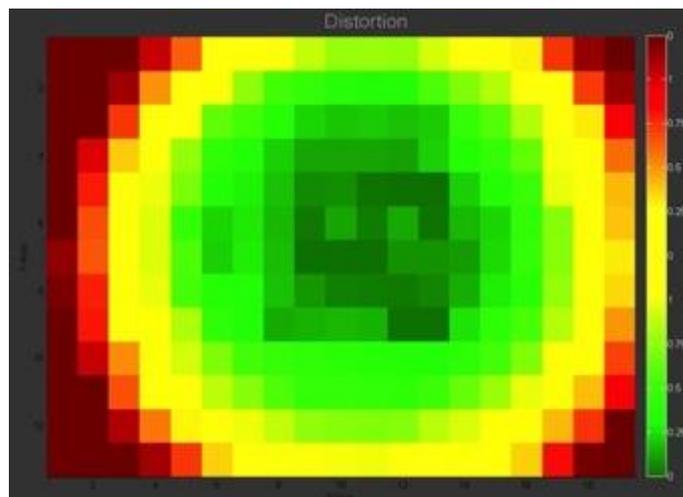
*Grid org:*

The illustration visualizes the distortion in the image with the aid of a distorted grid. X and Y are height and width of the image in pixel. The geometric distortion is plotted as a function of radial distance from the center of the image versus the lens geometric for each grid point.



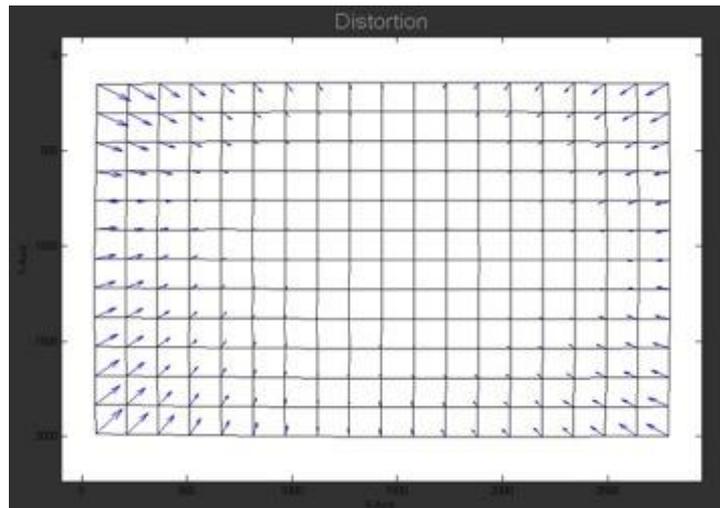
*2D:*

Distortion is shown in 2D view. Lens geometric distortion is visualized with colors. The warning level can be adjusted in the Advanced Settings. Each patch represents a cross in the image.



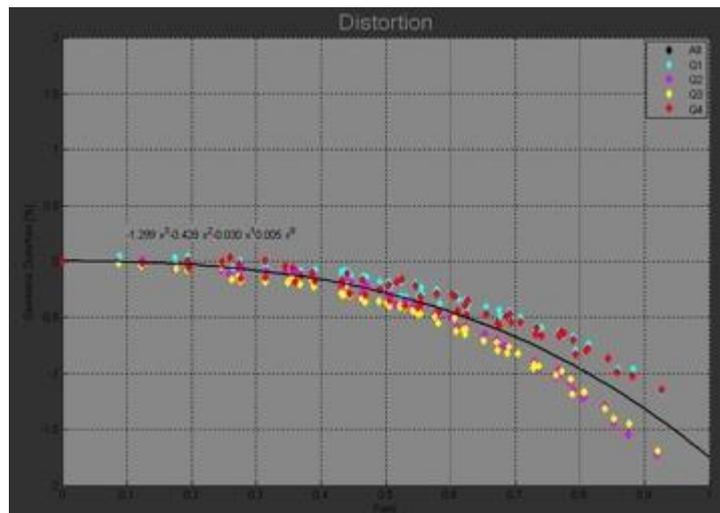
*Quiver:*

Distortion is displayed by vectors. The vector direction indicates the direction of distortion. Each dot represents a cross in the image. X and Y are height and width of the image in pixel.

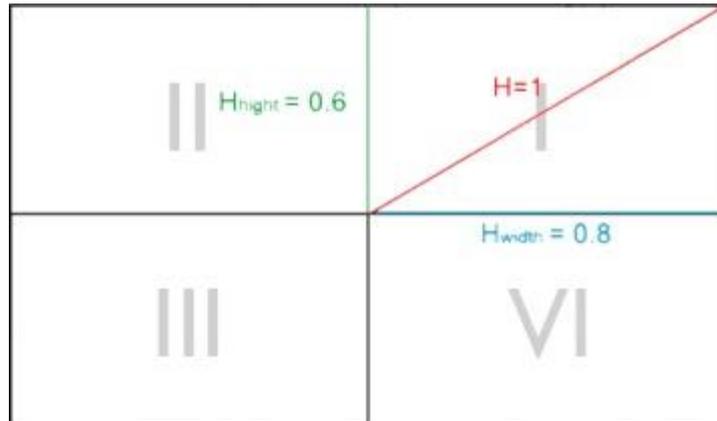


vs. *Field*:

The illustration shows the geometric distortion for every grid position (cross). The crosses are divided into the four quadrants and colored. The black curve indicates the line of best fit for all grid positions. The coefficients are also displayed. The degree of the polynomial can be set in the Advanced Settings (Poly.Fit Degree). If you select “LGD vs. Field – Fit Quadrants” in the Advanced settings, a line of best fit is displayed for every quadrant additionally.

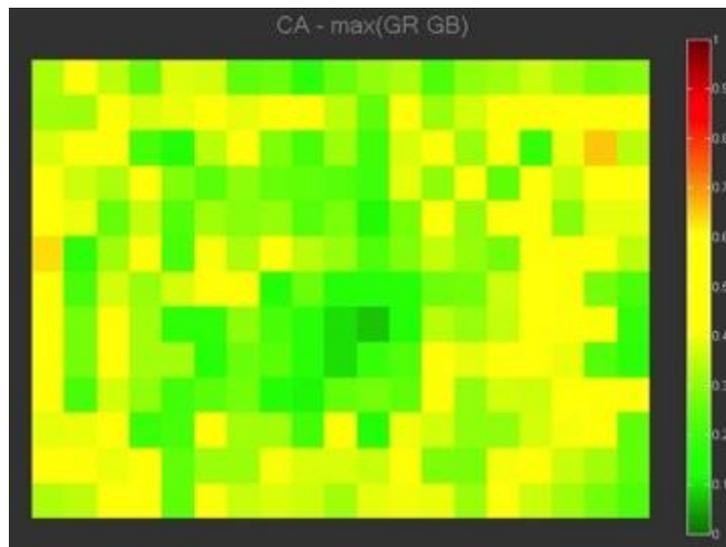


The x axis indicates the distance from center. The distance from center to one corner is set to  $H = 1$ . The two black vertical lines mark the half of picture height (0.6) and the half of picture width (0.8).



*CA – GR:*

The illustration visualizes the chromatic aberration in the image. You can choose representation of distance in pixel between the green and red channel ( $CA - GR$ ), the green and blue channel ( $CA - GB$ ) and the maximum of both.



*CA – GB:*

See  $CA - GR$

*CA – max:*

See  $CA - GR$

*CA – longitudinal:*

Describes the effect that the shape of the crosses vary for the three channels because the focus point shifts back and forth.

*CA – GR vs image height:*

To be added

*CA – GB vs image height:*

To be added

*CA – Quiver:*

To be added



### 8.7.4. Numerical results

On the right of the views you can display the numerical results by clicking on the arrow button. Hide the tables by clicking on the arrow button.

The top table shows the Exif data of the active image if stored by the camera. Below the Exif data the numerical results are outlined.

Distortion	
TV EBU[%]	0.2
TV SMIA[%]	0.4
Distortion	
LGD <sub>mean</sub>	0.1
LGD <sub>worst</sub>	0.5
LGD <sub>worst(fit)</sub>	0.4
Chrom.Ab.	
CA GR mean	0.17
CA GR max 10	0.41
Chrom.Ab.	
CA GB mean	0.07
CA GB max 10	0.22
LCA	
LCA horizontal	0.05
LCA vertical	0.05
LCA mean	0.05

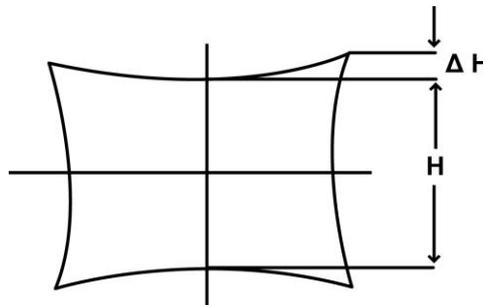
#### Distortion

*TV EBU [%]:*

The results of distortion calculation are shown as (EBU-) TV-Distortion and SMIA TV-Distortion (SMIA = Standard Mobile Imaging Architecture). The SMIA definition has been widely adopted in the mobile imaging industry.

In the traditional definition, TV distortion is the change ( $\Delta$ ) in the center-to-top distance divided by the bottom-to-top distance.

$$TV - Distortion = \frac{\Delta H}{H} * 100$$



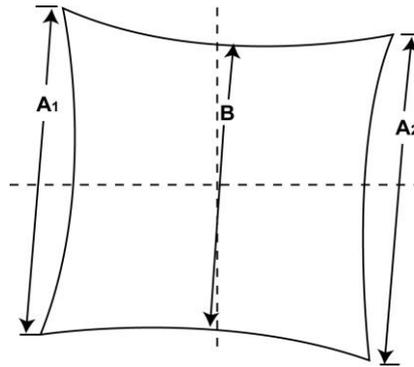
numerical result of distortion calculation

*TV SMIA [%]:*

In the SMIA definition, both A and B, are bottom-to-top distances.

$$SMIA - TV - Distortion = \frac{A - B}{B} * 100$$

$$A = \frac{A_1 + A_2}{2}$$



*LineGD (horizontal):* According to ISO 17850

$$\text{LineGD } h_i = \frac{|B_i - A_i|}{2V} \times 100\%$$

*LineGD h:* Line Geometric Distortion in horizontal direction

*A:* maximum height of the line grid pattern of the output image in pixels

*B:* minimum height of the line grid pattern of the output image in pixels

*V:* number of pixels of the short side of the frame of the output image

*i:* suffix presenting each picture height

*LineGD vertical:* According to ISO 17850

$$\text{LineGD } v_i = \frac{|\beta_i - \alpha_i|}{2V} \times 100\%$$

*LineGD v:* Line Geometric Distortion in vertical direction

*α:* maximum width of the line grid pattern of the output image in pixels

*β:* minimum width of the line grid pattern of the output image in pixels

*V:* number of pixels of the short side of the frame of the output image

*i:* suffix presenting each picture width

*LineGD total:* According to ISO 17850

$$|\text{LineGD total}_i| = \sqrt{\text{LineGD } h_i^2 + \text{LineGD } v_i^2} \%$$

*Zeichnung zu Line GD aus ISO Standard einfügen? Erlaubt? Eigene Zeichnung anfertigen?*

## LGD – Lens Geometric Distortion

The Lens geometric distortion is delivered in three different values:

*LGDmean:* The mean value is the average of lens geometric distortion of all grid positions (according to ISO 17850).

*LGDworst:* The worst value is the maximal value of distortion (according to ISO 17850).

*LGDworst(fit):* The worst(fit) is the worst value fitted to a polynom which degree is defined in the advanced settings (according to ISO 17850).

*LGD CPIQ:* Lens Geometric Distortion according to CPIQ definition.

## CA – Chromatic Aberration

*CA G-R mean:* The average distance in pixel between the green and red channel.



<i>CA G-R max10:</i>	The mean value of the ten largest distances between green and red.
<i>LCD GR [pix]:</i>	Lateral Chromatic Displacement in pixels between the green and red channel according to CPIQ. The distance between green and red channel is calculated based on polar coordinates. For the LCD GR the maximum values for green and red channel are used.
<i>LCD GR [%]:</i>	Lateral Chromatic Displacement in percent of the picture height between the green and red channel according to CPIQ. The LCD GR in pixels is set in relation to the image height in pixels.
<i>CA G-B mean:</i>	The average distance in pixel between the green and red channel.
<i>CA G-B max10:</i>	The mean value of the ten largest distances between green and blue.
<i>LCD GB [pix]:</i>	Lateral Chromatic Displacement in pixels between the green and red channel according to CPIQ. The distance between green and blue channel is calculated based on polar coordinates. For the LCD GR the maximum values for green and red channel are used.
<i>LCD GB [%]:</i>	Lateral Chromatic Displacement in percent of the picture height between the green and red channel according to CPIQ. The LCD GB in pixels is set in relation to the image height in pixels.

#### **LCA – Longitudinal Chromatic Abberation**

<i>LCA horizontal:</i>	Longitudinal chromatic abberation in horizontal direction measured on the center cross (horizontal part of cross)
<i>LCA vertical:</i>	Longitudinal chromatic abberation in vertical direction measured on the center cross (vertical part of cross)
<i>LCA mean:</i>	Mean value of the longitudinal chromatic abberation



## 8.8. FLARE

Upcoming ISO 18844 describes image flare as an unwanted increase in signal resulting from light incident on an image sensor that does not emanate from a corresponding subject point. The Flare module in combination with the TE281 enables you to determine the flare according to the ISO standard.



"Flare" tab

### 8.8.1. Settings

#### SETTINGS

##### OECF for linearization

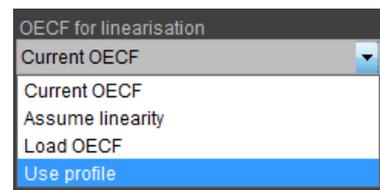
iQ-Analyzer needs OECF data for linearization:

*Current OECF:* iQ-Analyzer uses OECF data that is actually calculated and displayed in the OECF or TE42 module.

*Assume Linearity:* Flare can be calculated without a related OECF file. If no OECF is specified, a linear OECF can be used. If you use the linear OECF and your device does not work linear, the calculated will be incorrect.

*Load OECF:* If you want to use another OECF (or an idealized OECF), you can load an OECF result file from the iQ-Analyzer OECF module. Use the „...“ button and select an OECF .txt file.

*Use profile:* If the source file is an 8-bit per channel sRGB-image linearization is obtained following the ISO 18844 standard.



select linearization method

##### Subtract dark image

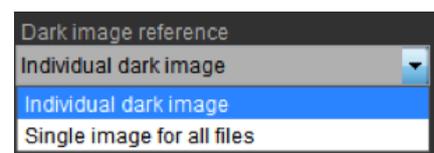
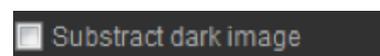
Subtracts a given dark image from the actual image source.

##### Dark image reference

The entered value is used to calculate a polynomial regression for certain displayed graphs.

*Individual dark image:* See "Dark image suffix"

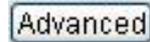
*Single image for all files:* Load one image that is subtracted from all images in the filelist if "subtract dark image" is checked.





## ADVANCED SETTINGS

By using the toggle button „Advanced“ the advanced menu opens.



### Chart illumination

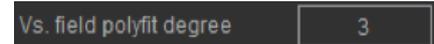
The measured illumination of the chart is entered here (default value: 1000 lx). The entered value will also appear in the results file.



Chart illumination [lux] 1000

### Polynomial fit

The entered value is used to calculate a polynomial regression for certain displayed graphs.



Vs. field polyfit degree 3

### Dark image suffix

If “Subtract dark image” is checked the entered text string is used to assign chart image and dark image. If two files differ only in the given suffix this file is supposed to be the dark image.



Dark image suffix \_dark

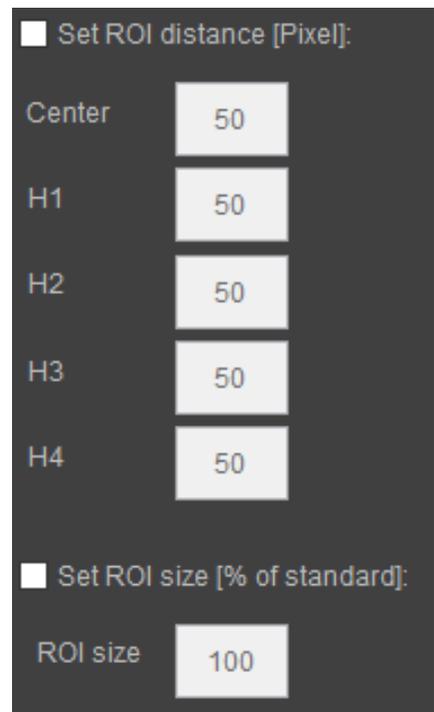
Example: flareImage\_00.tiff and flareImage\_00\_dark.tiff represent two corresponding files.

### Individual ROI settings

Note: These options are not compliant to any standard. If it is required to test according an standard please do not use these settings.

*Set ROI distance [Pixel]:* Change the distance between black and white reference ROIs for the five image heights (center to corners). This can be used to ensure, that the ROI is not placed within a blurred region in case of strong distortion.

*Set ROI size [% of standard]:* Change the default size of the ROIs. To ensure a meaningful measurement the sizes of all ROIs must be the same.

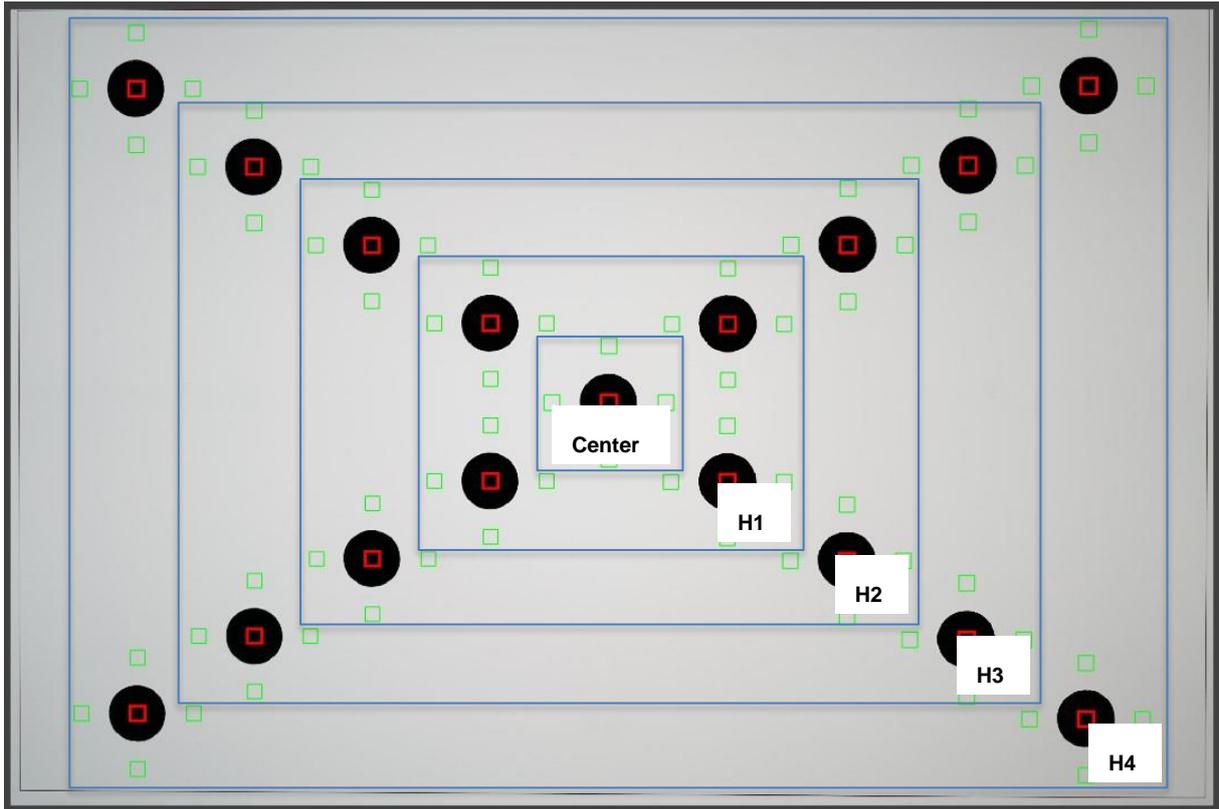


Set ROI distance [Pixel]:

Center	50
H1	50
H2	50
H3	50
H4	50

Set ROI size [% of standard]:

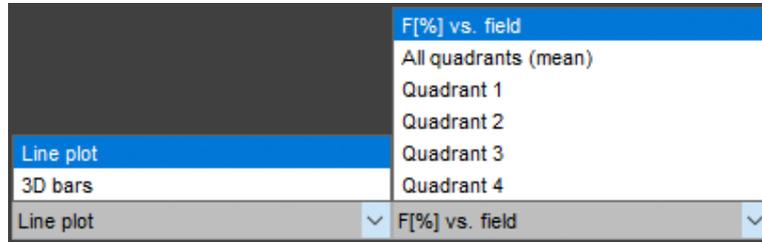
ROI size	100
----------	-----





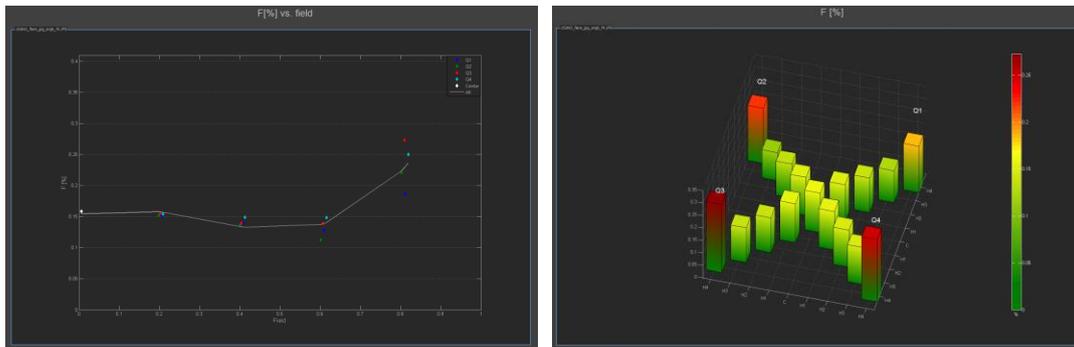
### 8.8.1. Graphical presentation

The graphical results are displayed in the *Result View* panel (center). Multiple dropdown menus are located below the graphical results.



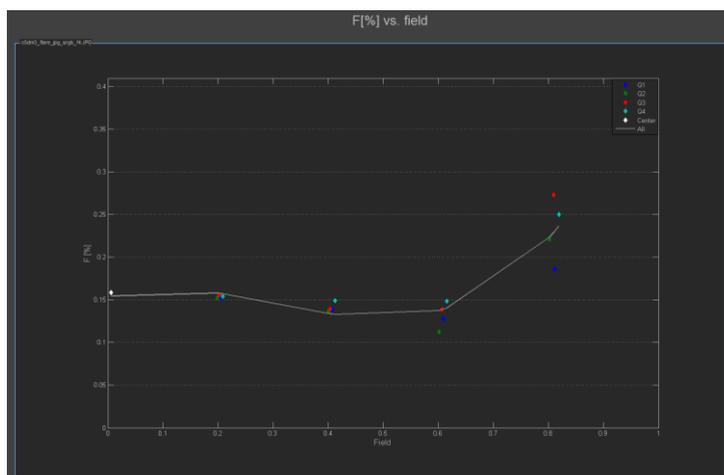
by using the dropdown menus you can select an image file and choose the displayed result

The left dropdown menu switches between line and 3D plot. The 3D-Plot shows each ROI as a bar. The colormap at the right of the plot indicates the value of each bar from 0 (green) to the maximum flare in the image (red)



*Line plot F[%]:*

The calculated results (F[%]) are plotted against the image height of the ROIs in the chart image. “field” is the ratio of the distance between an ROI and the image corner



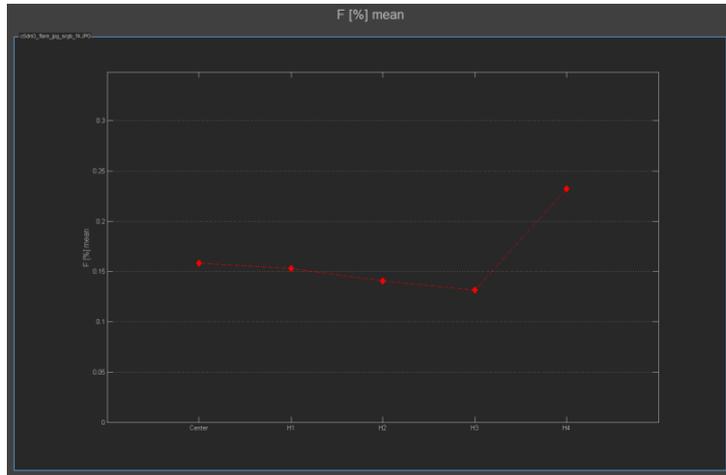


*All Quadrants {mean}*:

The calculated results (F[%]) as mean value of all quadrants are plotted against the image height of the ROIs in the chart image. A third-degree polynomial describes the curve "All".

*Quadrants 1-4:*

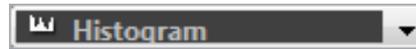
The calculated results (F[%]) for each quadrant are plotted against the image height of the ROIs in the chart image. Q1-Q4 represents the four different quadrants (Top-Right, Top-Left, Bottom-Left, Bottom-Right).





## 8.9. HISTOGRAM

The histogram modul calculates the intensity histogram and detects pixel that are outside the expected tonal range (e. g. dead or hot pixel). These pixel are saved in a table that can be imported by a camera for correction or used by external software.



“Histogram” tab

### 8.9.1. Settings

#### SETTINGS

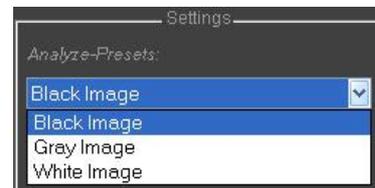
##### Analyze-Presets

Select the image layout. You can choose between three presets:

*Black Image:* A black image is produced by blocking all light from reaching the sensor, e.g. take an image in a total dark room or cover the lens.

*Gray Image:* Image , produced by taking a picture from a gray surface.

*White image:* Image, produced by taking a picture of a white surface.



select the chart layout

##### Substract Background

To substract the backround is more important for white and gray images than for black ones. Pixel that are outside the expected tonal range shall be detected. To avoid the influence of inhomogeneous illumination and shading, the background can be substracted from the image. Therefore a 7 x 7 filter is used to calculate the background.

##### Defect Pixel show DV outside

The threshold that is used to detect a pixel as defect can be set individually.

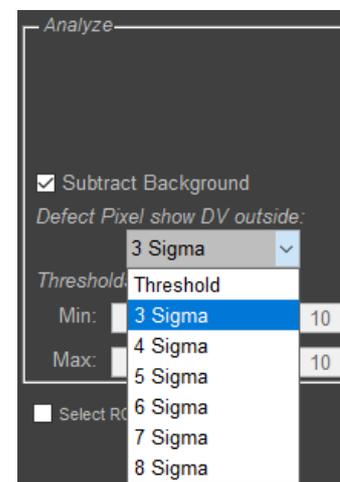
If the background is substracted :

*Thresholds:* If you have substracted background, insert values vor “- Mean” and “+ Mean” (values greater and less than the calculated mean value).

*x Sigma:* Standard deviation *Sigma*.

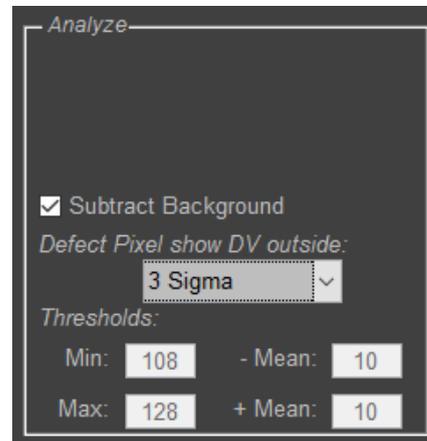
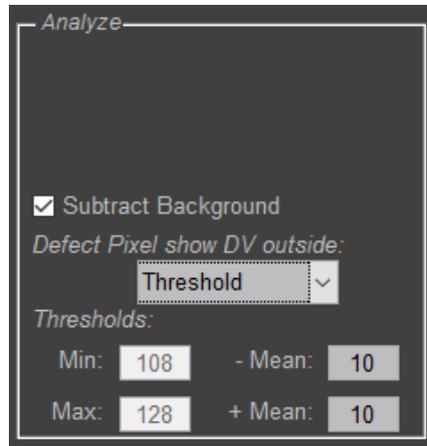
3 *Sigma* = 99.7300204 %

4 *Sigma* = 99.993666 %





5 Sigma = 99.99994267 %  
6 Sigma = 99.999998027 %  
7 Sigma = %  
8 Sigma = %



insert +/- Mean values as threshold or choose one of the standard deviations

If the background is not subtracted:

*Thresholds:* Insert values for "Min" and "Max".

### Select ROI

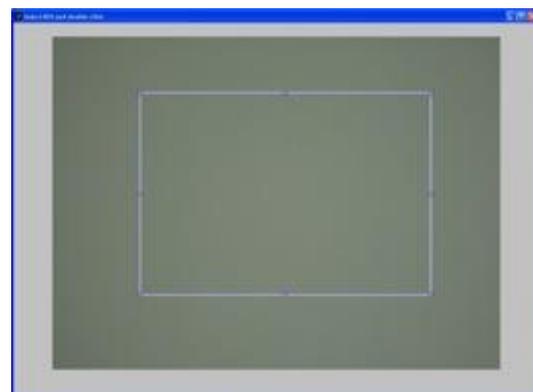
Enable the checkbox if you want to select the region of interest yourself. After doing all settings, press the „Start“ button. You can select the region of interest by



drawing a rectangle around the region and double click on it or use the right mouse button and press *Crop Image* and the analyzing process starts.



window for manual ROI detection



rectangle around your region of interest



## ADVANCED SETTINGS

By using the toggle button „Advanced“ the advanced menu opens.

Advanced

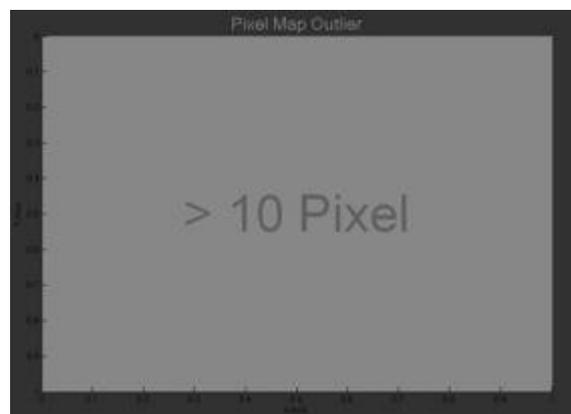
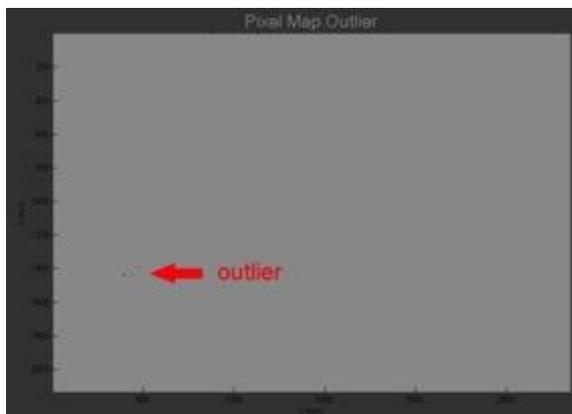
### Check Cluster

Enable this checkbox, if the defect pixel also shall be analyzed for clusters. A cluster contains of at least two adjacent pixel. This will increase the computing time.



### Maximum number of pixel that are reported in PixelMap and Resultfile

Set the level from this no display of outlier pixels in the pixelmap is shown.



left: number of outlier pixel is less than the level set in "Max Count PixelMap" and the pixels are shown in the pixel map  
right: number of outlier pixel is greater than the level set in "Max Count PixelMap" and an information ist shown

## 8.9.2. Graphical representation

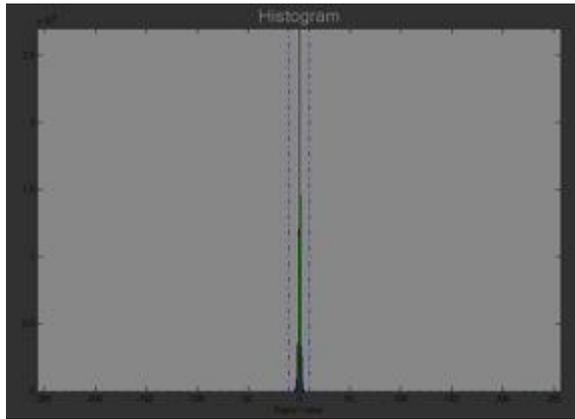
By using the first dropdown menu you can choose the displayed result: Histogram or Pixel Map. In case of Histogram you can choose between representation of direct and logarithmic (third dropdown menu). The analyzed images can be selected by using the second dropdown menu.



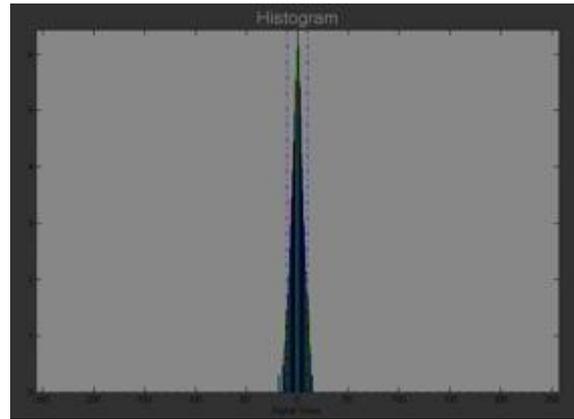
dropdown menu for selecting results, images and representation

### Histogram

In the histogram view the counts (direct or logarithmic) are displayed depending on the digital values. In this example „subtract background“ is enabled, so that the digital value of the filtered image is set to 0.

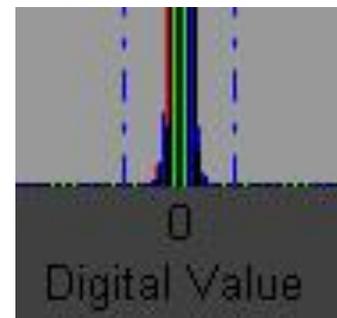


Histogram direct count



Histogram log count

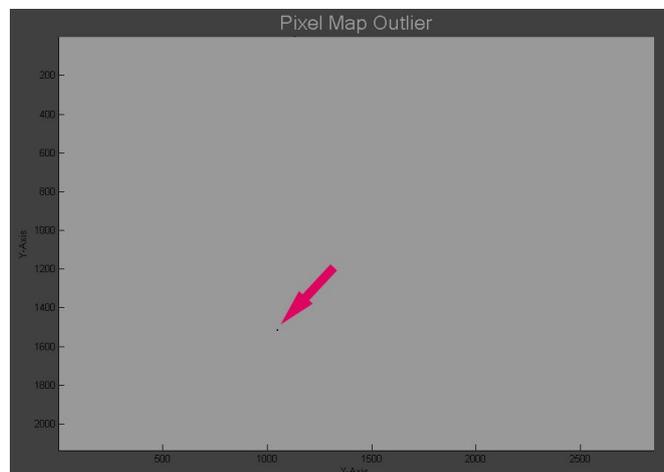
The two blue dashed vertical lines mark the defined tolerance range. Pixel inside are inside the expected tonal range. Pixel outside are detected as defect pixel. In this example four pixel (outlier) are outside the range.



the dashed blue lines mark the tolerance range

### Pixel Map

The Pixel Map indicates the outlier pixel in the image. X and y axes are image width and height displayed in pixel. In the result txt file the exact pixel position for Y, R, G and B are displayed and saved (Outlier 1: X=1034, Y=1598, ...)



Pixel Map with outliers, indicated with the red arrow

### 8.9.3. Numerical results

Below the graph two tables are shown with EXIF data and numerical results.



- Outlier:* 4 pixel are outside the expected tonal range
- Cluster:* a cluster contains of at least two adjacent pixel
- Mean:* The mean value for luminance Y and the three color channels R, G and B is 0
- Sigma:* The standard deviation for luminance Y and the three color channels R, G and B is 0.1
- Thres.High:* The mean value was set as 10
- Thres.Low:* The mean value was set as 10

	Y	R	G
Outlier	40006	63345	6
Cluster	-	-	-
Mean	0.0	-0.0	0
Sigma	0.0	0.0	0
Thres.High	10.0	10.0	1
Thres.Low	-10.0	-10.0	-1

numerical result of histogram calculation

The stored text file contains all coordinates of the outliers:

X-Pos(Y)	Y-Pos(Y)	X-Pos(R)	Y-Pos(R)	X-Pos(G)	Y-Pos(G)	X-Pos(B)	Y-Pos(B)
1	2	1	1	1	2	1	2
1	5	1	2	1	17	1	5
1	17	1	3	1	22	1	6
1	22	1	5	1	26	1	9

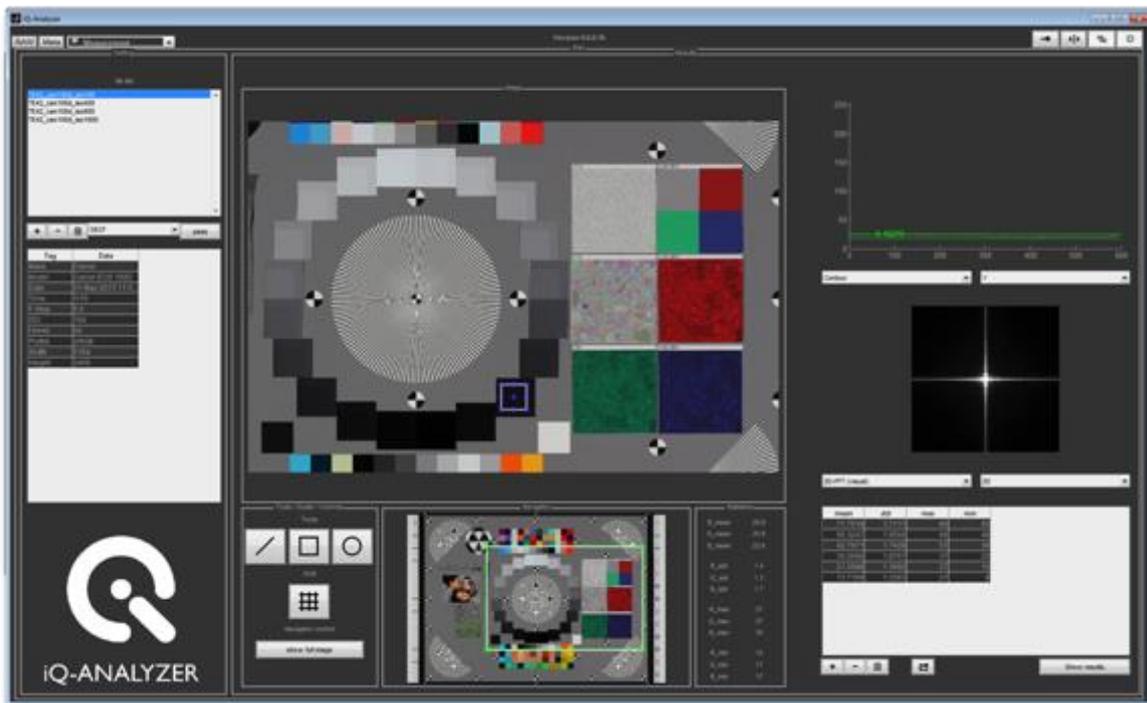


## 8.10. MEASUREMENT

The measurement module offers a bundle of measurement utilities. It is a handy modul for fast checks and as well for regular measurements.

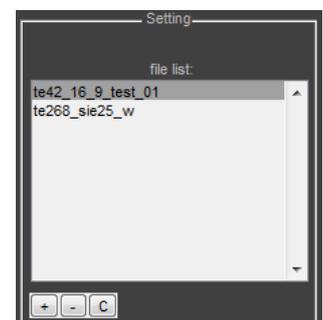
This module is not built for a specific chart layout. You can add every image file to the filelist or pass a video stream to this module. Choose the utility corresponding to your need.

### M Measurement



### 8.10.1. Settings & Meta data

Starting with the measurement module does not require any settings. Add files to the list in the left column as in all other module. Below the file list the meta data of the selected file is displayed.



### 8.10.2. Navigator & Control Panel

#### Image view

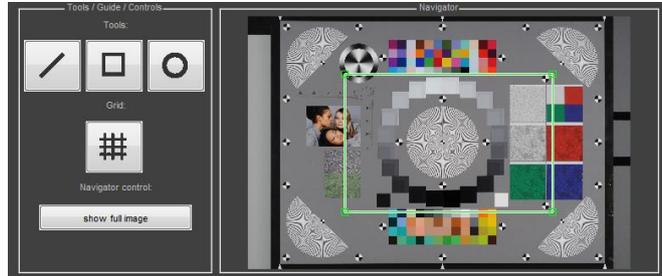
The image view shows the active file. Either the whole image or a part of it according to ROI adjustments in the navigator.



## Navigator

Below the image view the navigator is located. The navigator shows always the whole active image (marked in the file list). The image is framed by a rectangle which size and position can be adjusted to enlarge a specific area of the image. Place the mouse over a corner mark of the rectangle. It will appear as arrow. Now click and draw until required size is reached. The enlarged part is shown in the image area above.

To shift a rectangle place the mouse in the middle of the rectangle. The mouse will appear as 4-direction-arrow. Click and draw the rectangle to the required position.



## Tools

Next to the navigator-image the tools are listed.

Choose between the line, rectangle or circle figure to insert it to the image.



Clicking a second time and the tool will disappear.

The tools could be adjusted by click and draw at the corner marks (enlarge or shrink). Holding the shift key while resizing maintains the aspect ratio. You can also increase or decrease the tool size when scrolling the wheel of your mouse up and down. The aspect ratio is kept by using the mouse wheel. Click and draw somewhere at the middle of the tool to shift it among the image.



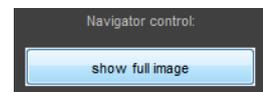
## Grid

The button inserts a grid that overlays the image. Each line can be adjusted by click at it and drawing it. Click at the button again and the grid will disappear.



## Show full image

Clicking at the „show full image“ button sets the ROI in the navigator to the whole image.



### 8.10.3. Utilities

The utilities deliver different results which could be observed in real time at diagram areas.

Two utilities can be activated at the same time. Choose a utility of each dropdown menu and select the value you want to be displayed from the second dropdown menu. The diagram area above shows the graphical presentation of the currently marked region. If no ROI is inserted the diagram area stay empty.

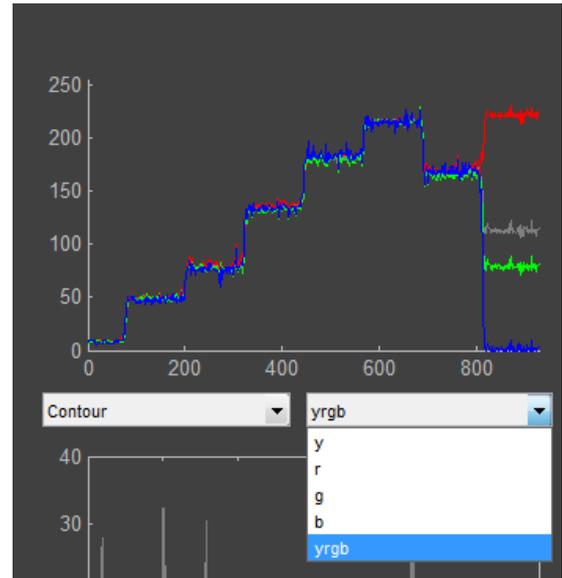


## Contour

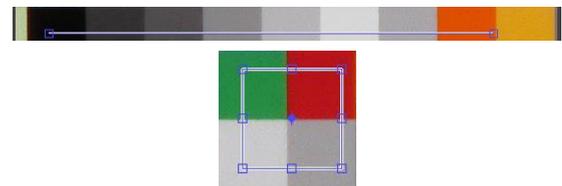
The Contour utility displays the digital value following the contour of the tool. The values could be displayed separated for Y, R, G, B or combining all channels.

*line tool:* The contour follows the line.

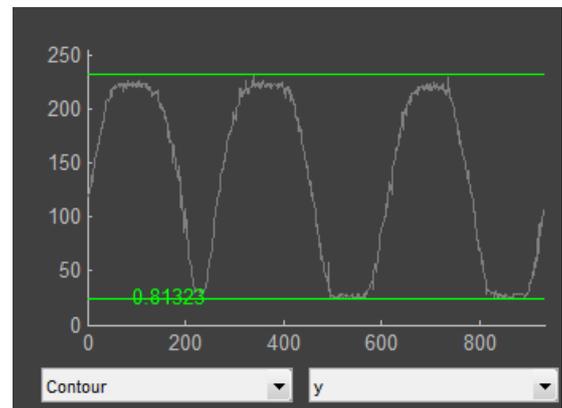
Note: The line tool has a start (left side) and an end point (right side). If you reverse the line the value picking still will begin at the start point, the former left side.



*rectangle tool:* The contour follows the rectangle clockwise beginning with the top left edge.



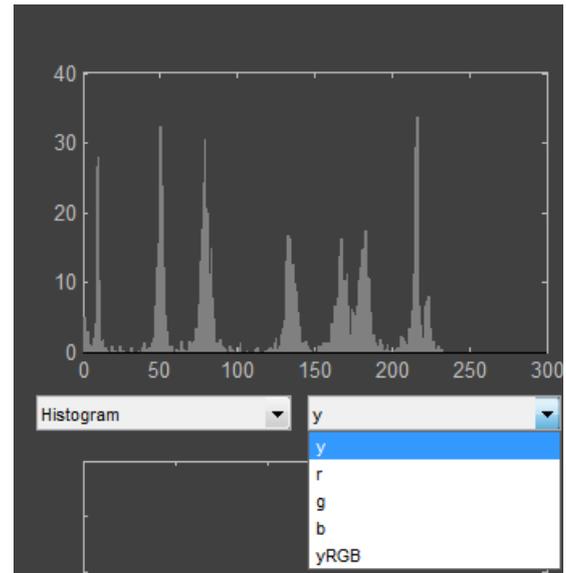
*circle tool:* The circle tool starts the contour at the right side (3 o'clock position) and follows the circle clockwise.





## Histogram

The histogram of the selected ROI is displayed. The view could be separated to Y, R, G and B or YRGB.



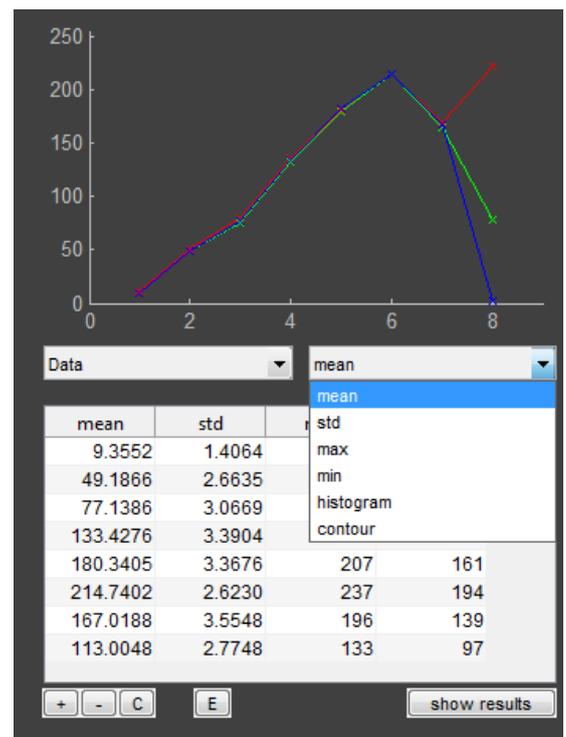
## Data

Choose *Data* to display the measurement values you capture. The values correspond to the table at the bottom right of the screen. The x-axis shows the ID number of the value (except histogram and contour).

The values are plotted for R, G and B (except histogram and contour).

The values are added either by clicking at „+“ beyond the table or by typing „m“ at your keyboard.

- mean*: The mean value of the selected ROI
- std*: Standard deviation between the values of the selected ROI
- max*: Plots the maximum value for selected ROI
- min*: Plots the minimum value for the selected ROI
- histogram*: Plot of the histogram for each ROI, the last captured values appears most redish, the earlier captured ones more blueish
- contour*: Plot of the contour for each ROI, the last captured contour appears most redish, the earlier captured ones more blueish.



## 2D-FFT

Plot of 2D fast fourier transformation for the active ROI.

## R/G B/G

Plot of color shading. The limits are set in the *Requirements* (even when deactivated).



### SFR (single edges)

Frame an edge in image by using the rectangle. Choose between two plots related to SFR\_edge:

*SFR:* SFR\_edge, determined for a single edge

*Profile:* The edge profile gives information about over and undershoot and edge width. The pixels are binned by their distance to the fitted edge description.

### VN

This utility calculates the visual noise on the active ROI.

### Derivative

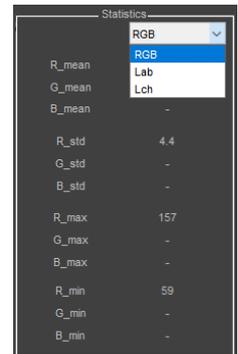
Tool to determine the best focus on a slanted edge or a Siemens star. The focus is best when the peak of the derivative is highest.

## 8.10.4. Numerical results

### Statistics

The statistics beyond the image view always show the actual values of the selected area. Chose between RGB, CIE L\*a\*b\* and CIE LCh.

- mean:* Average of the pixels in the ROI
- std:* Standard deviation of the pixels in each ROI
- max:* Maximum value in the ROI
- min:* Minimum value in the ROI



### Results Tables

You can collect values of the selected area. These values are collected in the table. The values can be displayed using the data utility. To export them there are two different ways.

At first the values can be marked manually. Mark more than one by holding the shift key while selecting. Using copy & paste to insert these values to any other document.

mean	std	max	min
212.0262	0.7596	214	209
205.2277	0.8187	209	201
197.2309	0.8822	201	194
187.4176	0.8417	191	184
177.9786	0.7991	182	175
168.8047	0.9023	172	164
159.5835	0.9698	163	155
146.1274	1.1493	152	142
132.4845	1.2985	137	127

The second option is to use the *Export* button. The results for each measurement value are printed in a report style (or not) using one page for each value. Each value is added by two prints of the selected utilities (at the time of taking the value). This report is either stored as pdf file or as postscript file due to the settings (see chapter 5.5.1).





## 8.11. Module 42

The module 42 is designed to analyze the test chart “Forty Two” (TE42). With one single chart OECF, dynamic range, resolution, shading, distortion, lateral chromatic aberration, color reproduction and kurtosis parameters can be measured according to ISO standards and analyzed with the iQ-Analyzer. The settings of the modules that are used for the module 42 can be seen if you load the TE42.myset in the setting module.



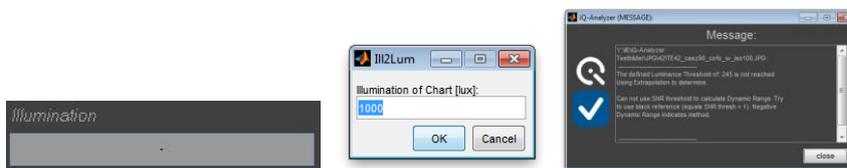
“42” tab

### 8.11.1. Settings

In contrast to the other modules, nearly all settings for the TE42 are predefined and stored within the .42 file. As a result there are no “Advanced Settings” available.

#### Illumination [lux]

Set the illumination of the chart. If you do not insert a value for illumination, a popup window will appear when you press the “Start” button.

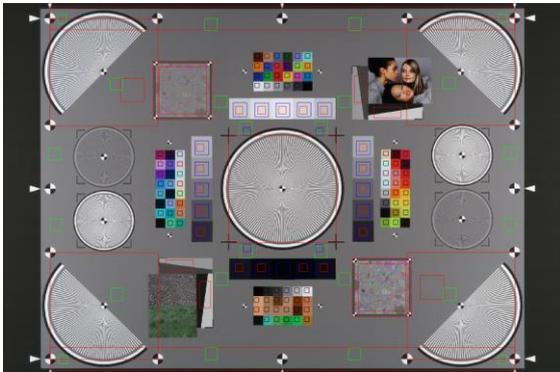


popup appears if you do not have set illumination

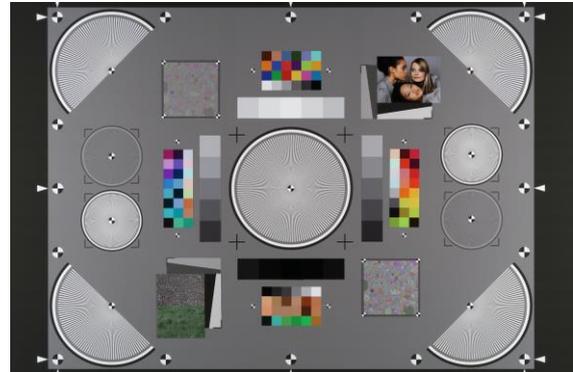


## 8.11.2. Graphical presentation

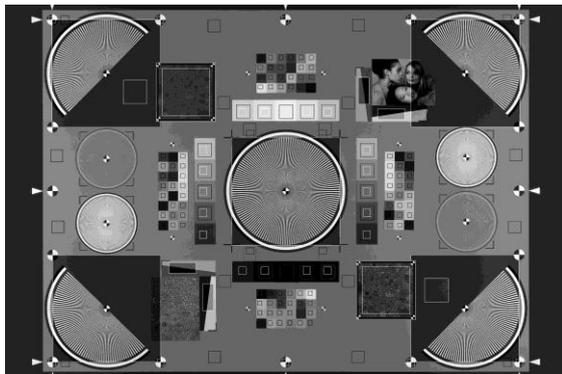
### IMAGE VIEW



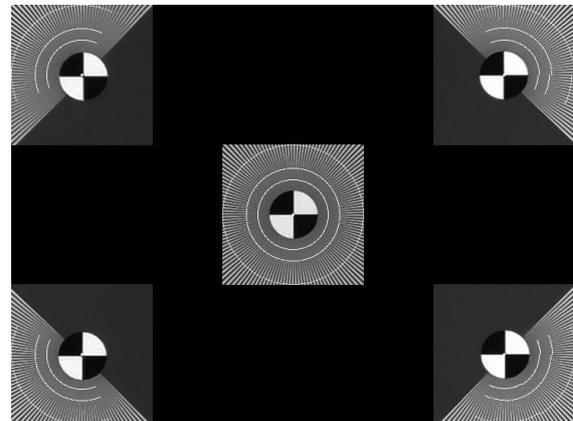
ROI with marked patches



Original



Check Image



Center Image

### RESULT VIEW

By pressing the „Result“ button, the graphical and numerical results are displayed in the right frame.



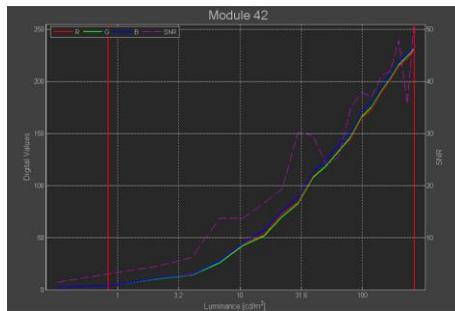
Depending on the the displayed result (selected with the first dropdown menu) the further menus offer different views

Below the graphical results are several dropdown menus. The first one allows choosing the result you want to be displayed (*OECF, Color, Resolution, Shading*). The further dropdown menus allow different views depending on the result you choose in the first menu (e.g. *Delta E, Delta L, Delta C, Delta H* for color analysis).

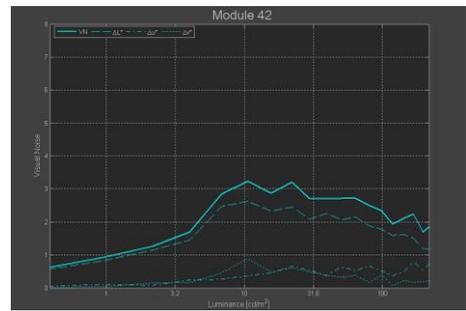


## OEFC

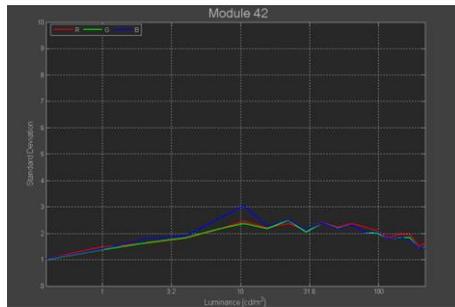
For details please refer to chapter 8.3.



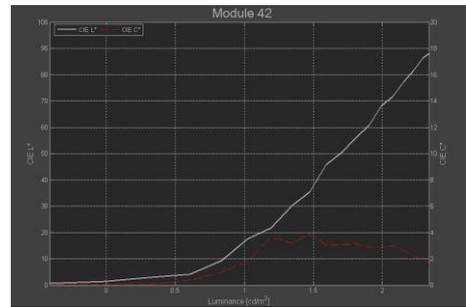
OEFC



Visual Noise



Noise



CIE

## Color

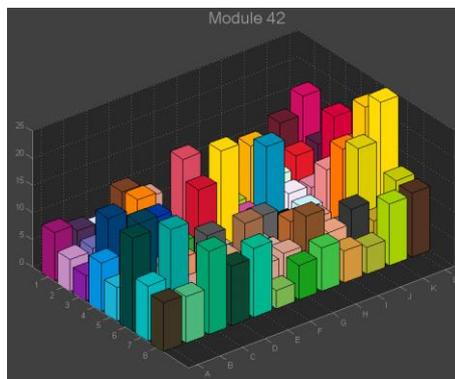
For details please refer to chapter 8.4.



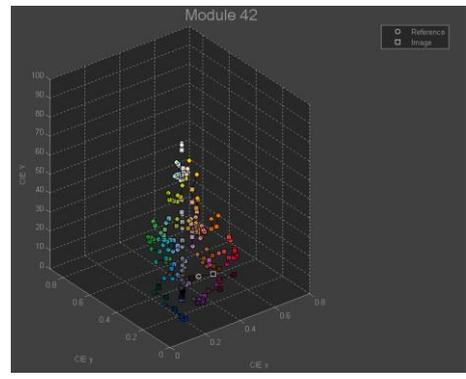
Numerical Results



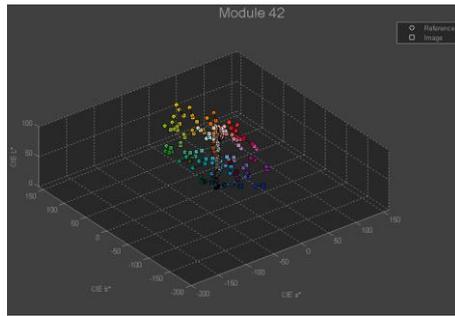
Visual Comparison



3D Bars



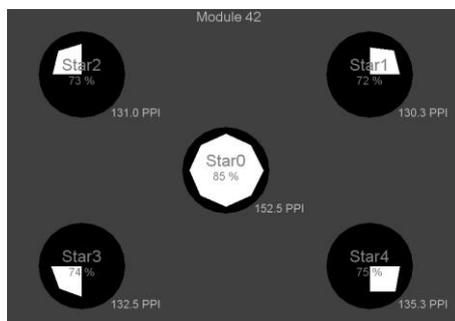
CIE xyY



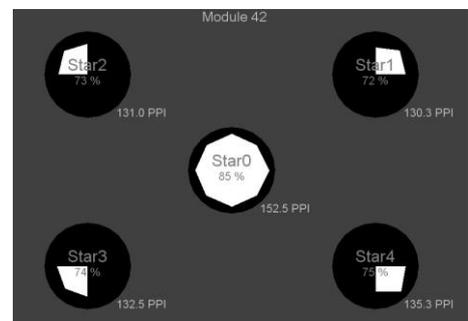
CIE L\*a\*b\*

## Resolution

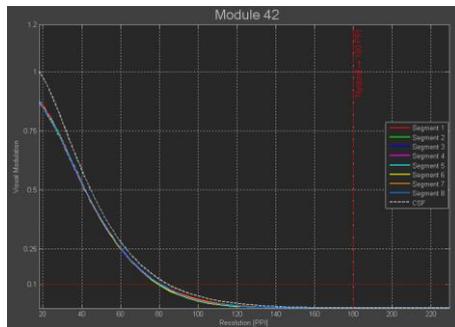
For details refer to chapter 8.5.



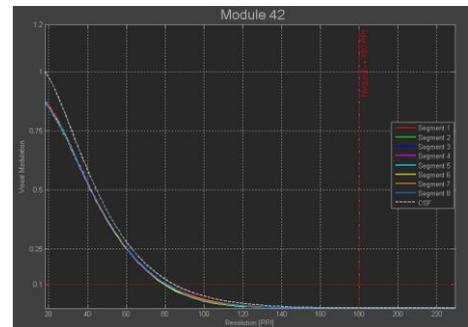
Overview



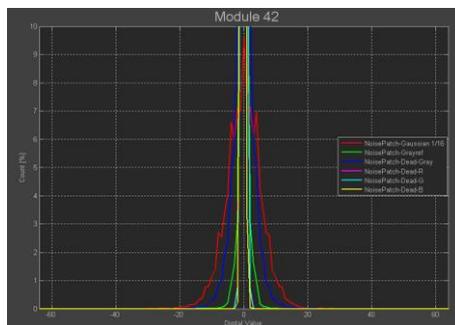
Stars



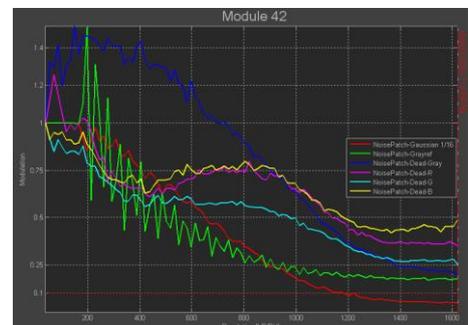
Segments



Groups



Noise/Histogram

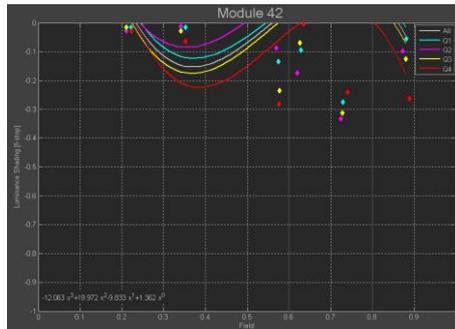


Noise/Spectrum

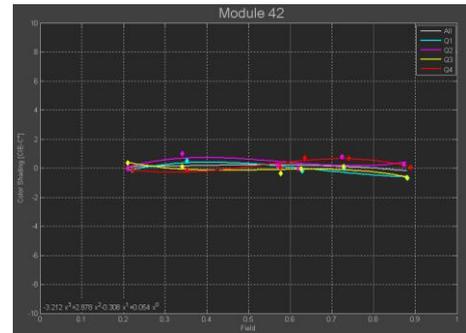


## Shading

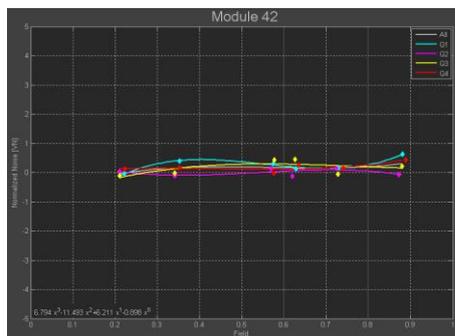
For details please refer to chapter 8.6.



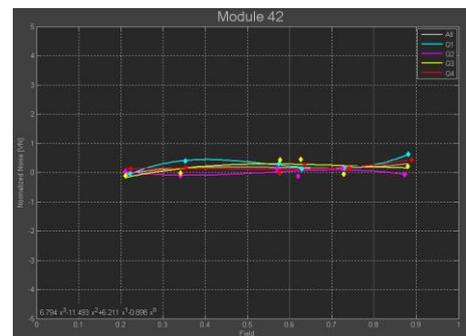
Luminance



Color



Visual Noise



Noise

### 8.11.3. Numerical results

For further information of the results for OECF, Color, Resolution and Shading please consult the relevant chapter in this documentation.

OECF	8.3.3 Numerical results
Color	8.4.3 Numerical results
Resolution	8.5.3 Numerical results
Shading	8.6.3 Numerical results



## 8.12. UTT

The UTT module is designed to analyze the Universal Test Target (UTT) according to ISO 19264:2017 and Metamorfoze Guideline and provides an insight into the complete image quality of all types of high end cameras and scanners used for archiving.

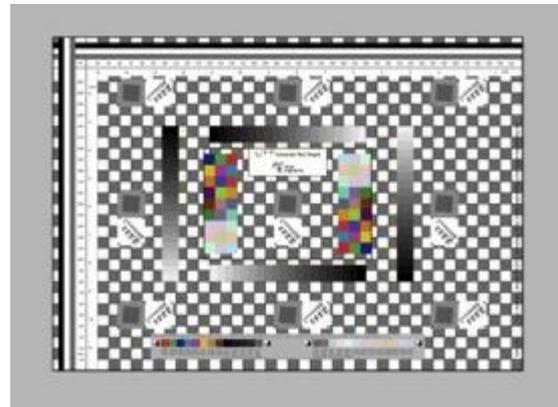


“UTT” tab

The UTT chart has either to be cropped exactly or the environment has to be nearly homogeneous; most suitable is a homogeneous white, gray or black background.

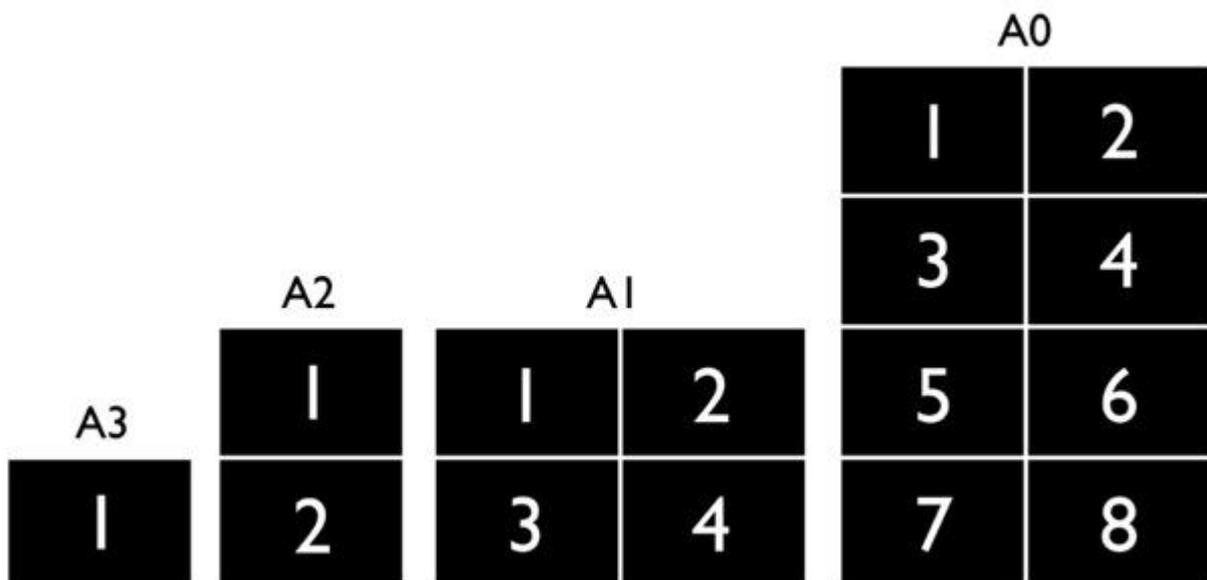


Cropped UTT target (DIN A3)



UTT target (DIN A3) in a homogeneous environment

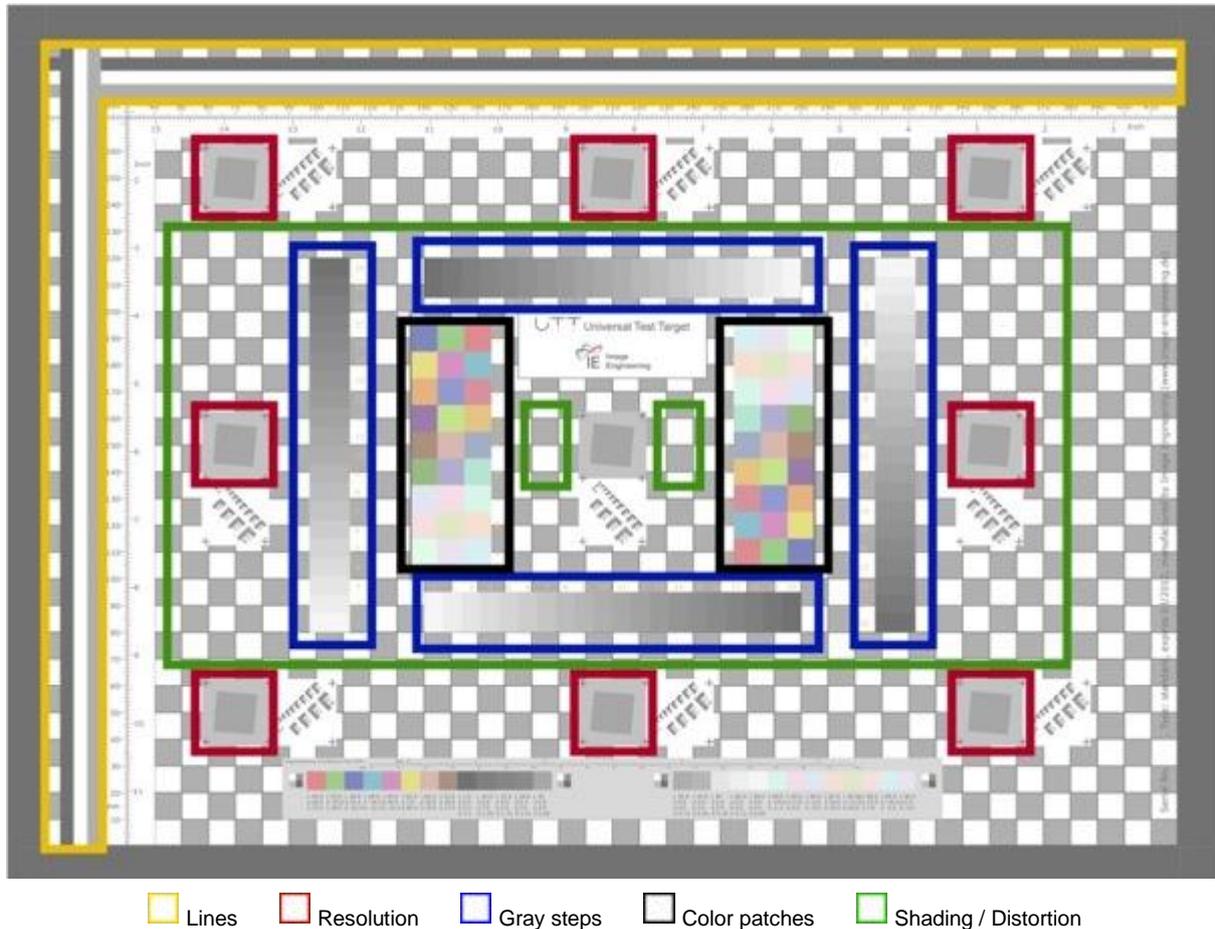
The UTT target is available in the DIN sizes A4 and A3 to A0. The formats A3 to A0 consist of tiles. A3 is one tile, A2 consists of two tiles, A1 of four tiles and A0 of eight tiles. The A4 format has a slightly modified design (only two gray scales and one set of color patches).





The UTT formats A3 to A0 consist of tiles

Used patches for measurement (exemplified by the A3 format):



Lines:

The yellow marked areas are used to test for dead lines that can occur during the scanning process and for shading (loss of intensity).

Resolution:

The nine red marked areas are used for resolution measurements.

Gray steps:

The blue marked areas are the four gray steps.

Color patches:

The two black marked areas are used for color measurements.

Shading + Distortion

The green marked areas are used for measurement of shading and distortion. Within the green rectangles the average of the white and the the average of the gray patches are determined for calculation of shading. Also the distances of the black lines are determined for distortion measurement.

Note: If an error message about not enough memory appears, you may try one of the following points:

- Restart the software
- Reboot windows



- Reduce volume of data because large image files might always lead to a memory error. Try to reduce the amount of data, e.g. by reducing from 16bit to 8bit externally or cropping unnecessary areas.
- Do not use the „Manual Mode“ for detecting the ROIs and leave the „Rotate Image“ menu to „0°“.
- Windows only: Increase virtual Memory and/or activate /3G switch (see Tech Note) [http://technet.microsoft.com/en-us/library/bb124810\(EXCHG.65\).aspx](http://technet.microsoft.com/en-us/library/bb124810(EXCHG.65).aspx)

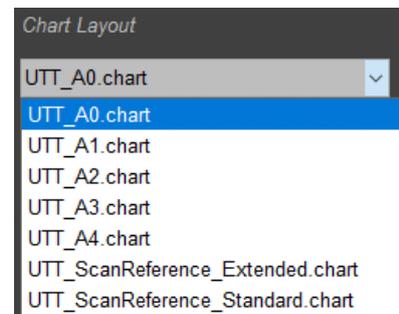
### 8.12.1. Settings

#### SETTINGS

After selecting the chart layout the UTT module needs the following adjustment:

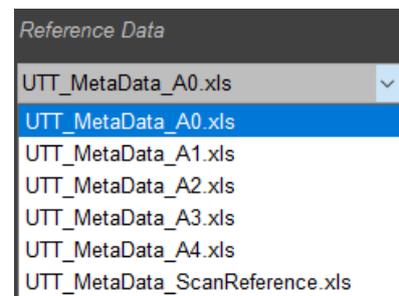
##### Chart Layout

The layout files (.chart) for the different sizes as well as for the two versions of the ScanReference chart can be chosen.



##### Reference Data

The reference files for the UTT and ScanReference charts are Excel files. The files are delivered with your chart if you ordered a mounted & measured chart. Use always the correct reference file for you chart. If you use an unmounted & unmeasured chart please use the default references delivered with iQ-Analyzer by default.

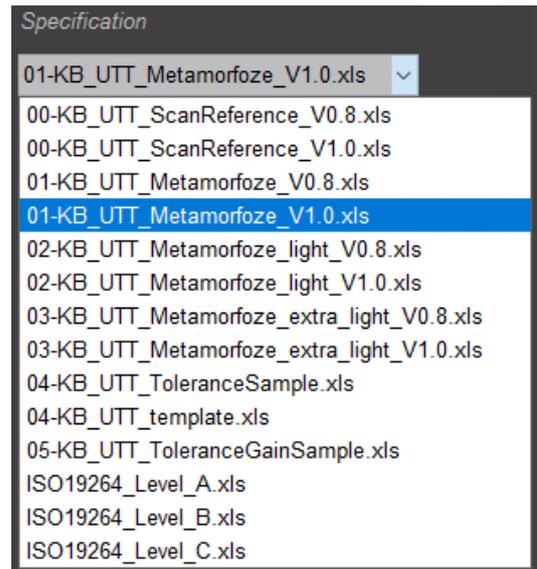


Note: when storing the Excel file ensure, that the sheet showing the reference data is on top. Otherwise iQ-Analyzer will reference to wrong cells and analysis will fail.



## Specification

The specification files define limits for acceptable results. The definition of the levels is based on different originals: Artwork, Unique Library, Non-Unique Library and others. The specifications are excel sheets. The specified range is displayed as green area in the graphical presentation.



*V0.8 / V1.0:* Indicates the version of the Metamorfoze Guideline the specification refers to.

*ScanReference:* Specific specifications for ScanReference charts.

*Metamorfoze level:* Metamorfoze, Metamorfoze light and Metamorfoze extra light are the three levels defined in Metamorfoze Guideline. Metamorfoze is the most strict level, Metamorfoze extra light the one with highest tolerances. For details please also refer to Metamorfoze Preservation Imaging Guideline:

[https://www.metamorfoze.nl/sites/metamorfoze.nl/files/publicatie\\_documenten/Metamorfoze\\_Preservation\\_Imaging\\_Guidelines\\_1.0.pdf](https://www.metamorfoze.nl/sites/metamorfoze.nl/files/publicatie_documenten/Metamorfoze_Preservation_Imaging_Guidelines_1.0.pdf)

*ToleranceSample:* Excel file with additional sheet for tolerances. Tolerances define an additional (wider) limit for the results. The specified tolerance range is displayed as yellow area in the graphical presentation. (ToleranceSample and ToleranceGainSample are two different presets.)

*04-KB\_U TT\_template:* Template for creating on specifications.

*ISO19264\_Level\_A-C:* Excel files including specifications for the three levels defined in ISO 19264:2017 standard.

Next to the limits and tolerances defined in the excel sheets additionally the color difference formula and the color profile is defined:

*Color difference formula:* Valid entries in cell B30 are:

- CIE1976
- CIE1994
- CIE2000 (1:1:1)
- CIE2000 SL1

*Color profile:* Valid entries in cell C30 are all valid color profiles like ECI RGB V2, Adobe RGB and others.

## Detection Mode



The manual mode is time and memory consuming. In most cases the automatic mode works satisfactorily.

Note: A further adjustment for the „Manual Mode“ is contained in the advanced settings.

## ADVANCED SETTINGS

### RGB Profile (if embedded Profile cannot be read)

For calculation of the image the embedded profile is used. If the profile cannot be read or no profile is embedded, the profile is used that is set here.

The specifications describe the profile that is used for comparison of the image. Most specifications use the eciRGB profile version 2 for calculations and comparison. If the image contains a different profile than eciRGB v2 a warning appears, that the profile of the image do not conform to the profile of the specification.



### “Manual Mode” in “ROI Detection”

Beside the automatic mode for ROI (region of interest) detection a manual mode can be chosen. If the manual mode is selected, there are two alternatives

- Crop Image:* Select the chart, further detections are done automatically
- Crop Image & Adjust Patches:* Select the chart and adjust the patches

### Writing Meta Data to File

The results are written into the IPTC tag. Using the „?“ button a popup window appears and you are linked to the website with the Exif tool of Phil Harvey. Using MAC OS X you need to install the Exif tool. If you are using Windows the exiftool.exe is installed already.



“?” button and popup window with information about the required Exif tool

### Write IPTC Tag

The IPTC tag „Caption-Abstract“ is used to include own information about the image or measurement in the image.

„Caption-Abstract“ correspond to the XMP tag "ImageDescription". When reading the meta data, e. g. with Exif tool, you can see the updated/included text. iQ-Analyzer write the text from the „Notes“ field in the Advanced Aettings to this tag.





**Note:** If you want to keep the original file "un-touched" please do not use this option or combine it with the function "keep original file". In this case the analysis is performed on a copy of the original file and the extension of original is changed to .tiff\_orig.

### Keep Original File

If the checkbox is enabled the Exif tool first makes a copy of the original file („filename.tif\_original“). The copy is modified during analysis (IPTC tag is written). If you later want to use the original file, you have to delete the part „\_original“ from the filename.

If the checkbox is not enabled, the original file is modified during the analyzing process. Recommended is to enable the checkbox.

### Notes

The inserted notes are also written into the IPTC tag.



### Write reference file

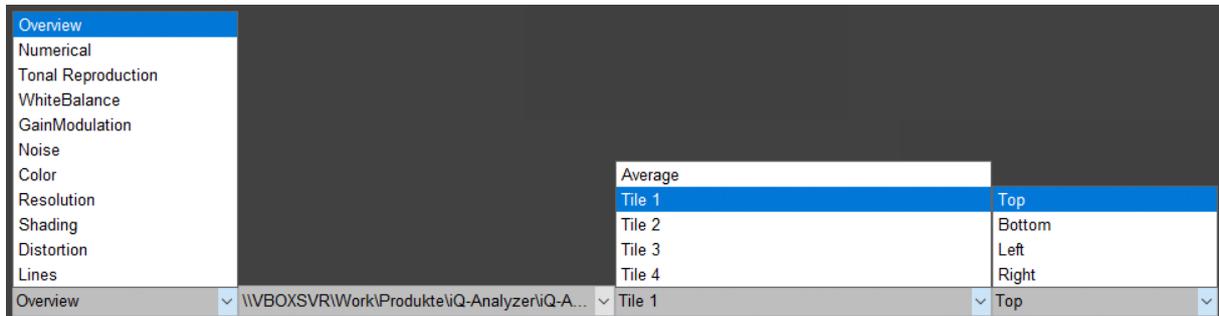
To be added



## 8.12.2. Numerical results and graphical presentation

### RESULT VIEW

By pressing the „Result“ button, the graphical and numerical results are displayed in the right screen.



depending on the the displayed result (selected with the first dropdown menu) the further menus offer different views

In the *Result View* you can choose the presentation of the results by using the dropdown menu at the bottom left.

For chart sizes larger than A3 the results are differentiated into the tiles and also available as average over all tiles (*Average*“, „*Tile 1*“, „*Tile 2*“, ...).

In most of the *Result Views* a further dropdown menu enables you to switch between the results for the top, bottom, left or right gray scale.

### OVERVIEW

The UTT Modul displays an overview after calculation is finished. This overview contains a classification of the analyzed parameters (Tonal Reproduction, Noise, Color, Resolution, Shading, Distortion, Lines) due to the used specifications which define the tolerances.



The result is outside the limits that are specified in the selected specification (Metamorfoze, ISO Level A, ...).



The result is within the selected specification.



The result is outside of the specification but inside of the the tolerance.



## NUMERICAL

Neutral	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
L*ref	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00
L*sample	34.80	38.28	34.53	29.52	24.41	20.61	14.36	9.40	54.76	49.64	44.82	38.95	34.88	30.78	25.71	20.79	15.64	10.26	4.31	0.00
delta L																				
delta L spec_Max	1.00	3.00	1.00	3.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
delta E																				
delta E spec_Max	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
delta C																				
delta C spec_Max	1.00	1.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
DeltaMod																				
DeltaMod spec_Max	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00
ITD																				
ITD spec_Max	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Background information concerning Lab, LCh, Delta E, Delta L, Delta C, Delta H: If you express the Lab color space in polar coordinates you get LCh, where L is the luminance, C the chrominance (saturation) and H the hue (color tone). Delta E indicates the overall difference between reference and sample. The calculation method is defined in the specifications. To get more detailed information about the difference it is interesting to see the difference in luminance (Delta L) and hue (Delta H).

### Neutrals

The results are displayed for the 20 gray patches of the gray scales. Using the dropdown menu you can switch between the four gray scales (top, bottom, left, right). Values outside the tolerance range are indicated red.

- L\*ref* Luminance of the reference (specifications)
- L\*sample* Luminance of the image
- delta L is* Calculated luminance difference ( $L^*_{sample} - L^*_{ref}$ )
- delta L spec\_Max* Tolerance limit defined in the specifications
- delta E is* Calculated color difference
- delta E spec\_Max* Tolerance limit defined in the specifications (Metamorphoze only)
- delta C is* Calculated chrominance difference ( $C^*_{ref} - C^*_{sample}$ )
- delta C spec\_Max* Tolerance limit defined in the specifications



<i>GainModulation is_L</i>	(Sample $\Delta L$ / Reference $\Delta L$ ) x 100
<i>GainModulation is_E</i>	(Sample $\Delta E$ / Reference $\Delta E$ ) x 100
<i>GainMod spec_Max</i>	Maximum tolerance limit defined in the specifications
<i>GainMod spec_Min</i>	Minimum tolerance limit defined in the specifications
<i>STD is</i>	Calculated standard deviation of each patch (Metamorfoze only)
<i>STD spec_Max</i>	The standard deviation is not relevant for the specifications (Metamorfoze only)
<i>VisualNoise is</i>	To be added (ISO 19246 only)
<i>VisualNoise spec_Max</i>	To be added (ISO 19246 only)
<i>DynamicRange is</i>	To be added (ISO 19246 only)
<i>DynamicRange spec_Max</i>	To be added (ISO 19246 only)

Example for Gain Modulation:

Sample  $L^*a^*b^*$  values of the horizontal lower gray patches number 1 and number 2 of the UTT.

UTT	$L^*$	$a^*$	$b^*$	Delta L	Delta E
Gray patch 1	92.59	-0.88	-0.12		
Gray patch 2	89.82	-0.74	0.82	2.77	2.93

Reference  $L^*a^*b^*$  values of the lower gray patches 1 and 2 of the UTT.

UTT	$L^*$	$a^*$	$b^*$	Delta L	Delta E
Gray patch 1	95	0	0		
Gray patch 2	92	0	0	3	3

Gain Modulation based on Delta L is:  $2.77 / 3.00 = 0.92$  A 92% (OK)

Gain Modulation based on Delta E is:  $2.93 / 3.00 = 0.98$  A 98% (OK)

**Color**

<i>delta E is</i>	The average (Mean), the maximum ( Max) Delta E of all color patches
<i>delta E Spec</i>	Tolerance limit defined in the specifications
<i>delta E Patch</i>	Patch number with the highest Delta E
<i>delta L is</i>	The average (Mean) and the maximum ( Max) Delta L (luminance) of all color patches
<i>delta L Spec</i>	Tolerance limit defined in the specifications
<i>delta L Patch</i>	Patch number with the highest Delta L
<i>delta C is</i>	The average (Mean) and the maximum ( Max) Delta C (chrominance) of all color patches
<i>delta C Spec</i>	Tolerance limit defined in the specifications
<i>delta C Patch</i>	Patch number with the highest Delta C



---

<i>delta H is</i>	The average (Mean) and the maximum ( Max) Delta H (hue) of all color patches
<i>delta H Spec</i>	Tolerance limit defined in the specifications
<i>delta H Patch</i>	Patch number with the highest Delta H



## Grid

<i>Delta White is</i>	Absolute reference values (Ref) for the lightness ( $L^*$ ) of the white patches of the checker board and the differences Delta L between the reference and the sample
<i>Difference White spec_Max</i>	Maximum tolerance limit defined in the specifications
<i>Delta Gray is</i>	Absolute reference values (Ref) for the lightness ( $L^*$ ) of the gray patches of the checker board and the differences Delta L between the reference and the sample
<i>Difference Gray spec_Max</i>	Maximum tolerance limit defined in the specifications
<i>Distortion is</i>	The width of the squares are compared to the average width over the whole image. The result of the distortion measurement is given as percentage. The reference value "Ref" is the average width over the whole image.
<i>Difference [%] Distortion spec_Max</i>	Maximum tolerance limit defined in the specifications

## Resolution

Resolution is measured on the nine resolution patches (top left, top center, top right, center left, center center, center right, bottom left, bottom center, bottom right), at each horizontal and vertical slanted edges (left, right, top, bottom). Also the mean average is calculated.

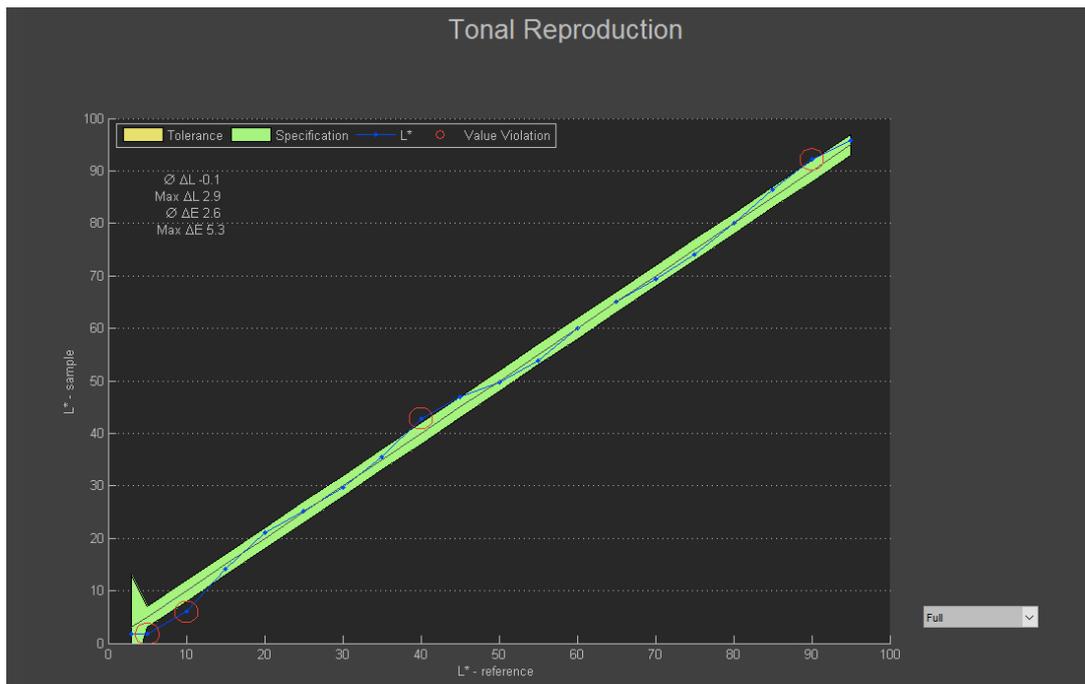
<i>SamplingEff is</i>	Average of the the sampling efficiency of the four edges (Metamorfoze only)
<i>SamplingEff spec_Min</i>	minimum tolerance limit defined in the specifications (Metamorfoze only)
<i>Sampling Efficiency (horizontal vs. vertical)</i>	If the limiting frequency equals Nyquist frequency, sampling efficiency ist 100% (Metamorfoze only)
<i>MTF10[lp/mm] is</i>	MTF10 is the highest spatial frequency with a modulation greater than 10% (linepairs/mm or ppi).
<i>MTF10[lp/mm] spec_Min</i>	Minimum tolerance limit defined in the specifications (Metamorfoze only)
<i>MTF [%] is</i>	To be added (ISO 19246 only)
<i>MTF [%] spec_Min</i>	To be added (ISO 19246 only)



<i>MTF 50 [lp/mm]</i>	MTF50 is the highest spatial frequency in linepairs/mm with a modulation greater than 50%.
<i>MTF50[lp/mm] spec_Min</i>	Minimum tolerance limit defined in the specifications (Metamorfoze only)
<i>MTF [%] is</i>	To be added (ISO 19246 only)
<i>MTF [%] spec_Min</i>	To be added (ISO 19246 only)
<i>MaxModulation is</i>	The calculated modulation of the sample
<i>MaxModulation spec_Max</i>	Maximum tolerance limit defined in the specifications; due to sharpening during the digitalization of the image, values could be greater than 1.
<i>Diff_horver [%] is</i>	Difference between the horizontal and vertical resolution (Metamorfoze only)
<i>Diff_horver [%] spec_Max</i>	Maximum tolerance limit defined in the specifications (Metamorfoze only)
<i>MisReg. [px] is</i>	On the four slanted edges the maximal shift of the color channels is measured (shift of the red and green channel and shift of the blue and green channel).
<i>MisReg. [px] spec_Max</i>	Maximum tolerance limit defined in the specifications
<i>Claimed Sampling Rate</i>	sampling rate specified in the meta information of the file. Most likely the sampling rate is set in the control software (ppi and the related lp/mm). If it can not be obtained the default setting will be used instead. It can be changed in the SETTINGS tab.
<i>Obtained Sampling Rate</i>	sampling rate measured on the image (using the average distance of the black lines in the background).
<i>Obtained Sampling Rate is</i>	To be added (ISO 19246 only)
<i>Obtained Sampling Rate spec_Min</i>	To be added (ISO 19246 only)
<i>Resolved Elements</i>	Obtained sampling rate x sampling efficiency (usable sampling rate)

## TONAL REPRODUCTION

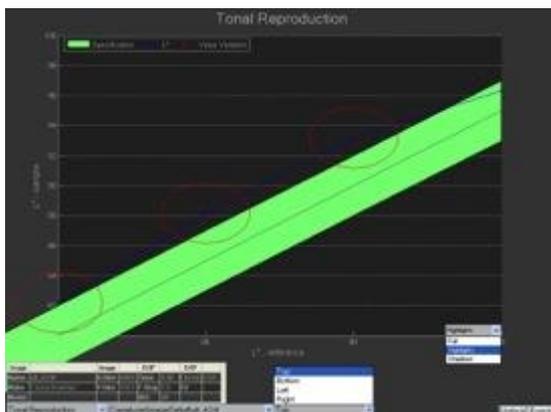
The graph displays the tonal reproduction of the gray scales: Luminance of the reference (specification) vs. luminance of the sample. The four gray scales can be selected by using the dropdown menu.



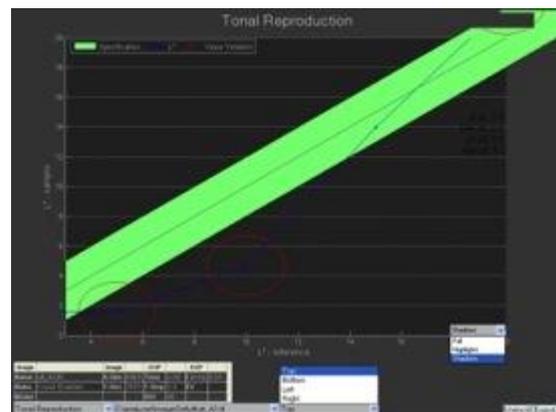
Tonal Reproduction "Full"

The thin black line represents the luminance reference values  $L^*_{Ref}$  (defined in the specifications), the blue line represents the luminance results  $L^*$  of the analyzed UTT chart. The tolerance range, that is also defined in the specifications, is displayed in green. Values that are outside the tolerance range are outlined in red „Value Violation“. Numeric results are displayed for the average and the maximum of  $\Delta L$  (luminance difference) and  $\Delta E$  (color difference).

The dropdown menu down right of the graph enables an enlarged view of parts of the graph: Highlights and Shadows.



Tonal Reproduction „Highlights“



Tonal Reproduction „Shadows“



## WHITE BALANCE

The graph displays the adjustment to keep the gray scale neutral. Outlined are the luminance  $L^*$  vs. the color difference  $\Delta C^*$  of the gray scales.

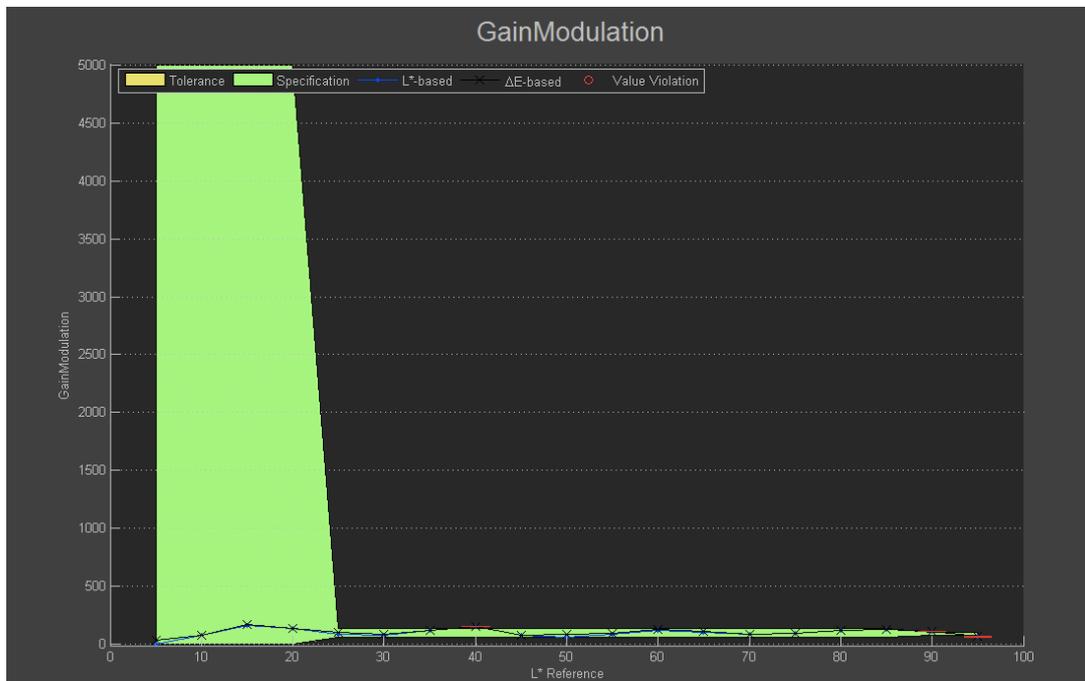


At best  $\Delta C^*$  is 0 (no color cast). The tolerance range, that is defined in the specifications, is displayed in green. Values that are outside the tolerance range are outlined in red „Value Violation“.



## GAIN MODULATION

Gain modulation describes the reproduction of the sample in digital values. It is a comparison between the steps of the sample and the resulting digital values. At a reproduction of 1:1 (e.g. 4  $\Delta L$  between two patches in the sample correspond to 4  $\Delta L$  in the digital scanned image) the result is 100%.



The thin black line represents the gain modulation based on  $\Delta E$ , the blue line represents the gain modulation based on  $L^*$ . The tolerance range, that is defined in the specifications, is displayed in green. Values that are outside the tolerance range are outlined in red „Value Violation“.

## NOISE

Noise measurement (standard deviation, STD) is made using two methods.

1. STD neutrals (thin black line): Noise is calculated on the patches of the gray steps. Due to the production process of the chart, the neutrals may show slight structures which lead to higher measured STD.
2. STD srnoise (blue line): The resolution patches are selected because these patches do not exhibit any structure. The measured standard deviation is a result of the noise introduced by the scanning device.



The tolerance range, that is defined in the specifications, is displayed in green. Values that are outside the tolerance range are outlined in red „Value Violation“.

## COLOR



On the left side the numeric results for each patch are shown and the amount of the color difference is visualized by colors - from dark green ( $\Delta E = 0$ ) to dark red ( $\Delta E = \text{maximum value defined in the specification}$ ). On the right side a visual comparison of the color patches are shown (left: image, right

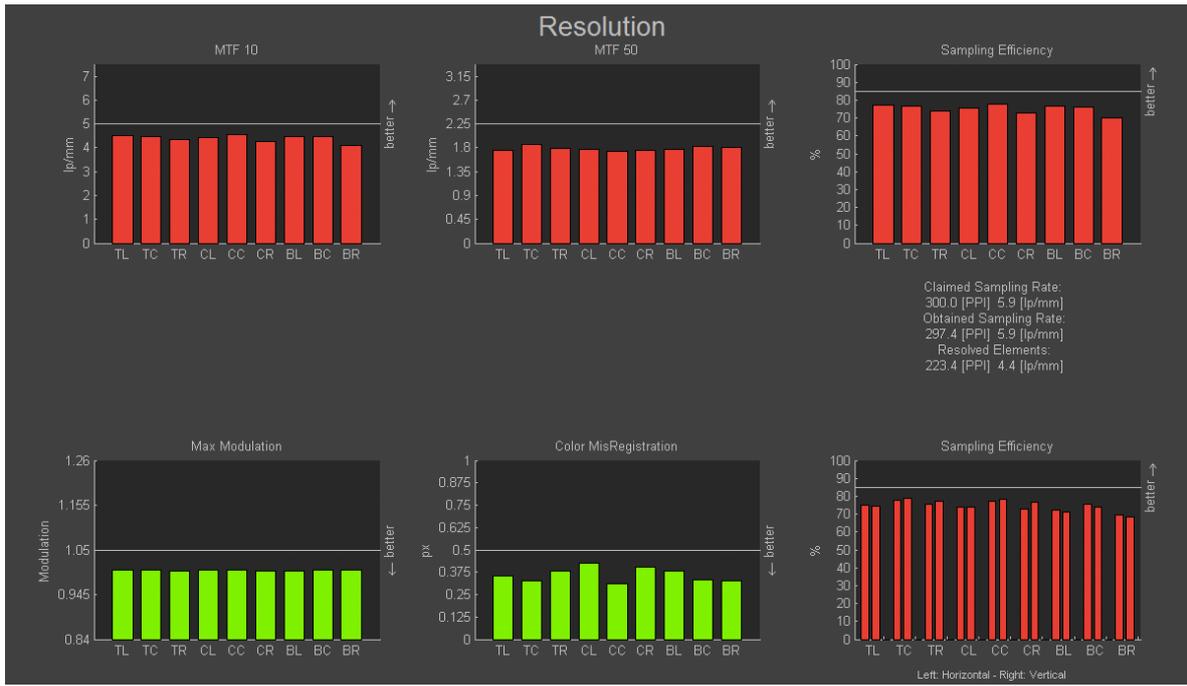


reference). The values for the color differences are defined in the specifications. You can choose between the display of results for  $\Delta E$  (color difference),  $\Delta L$  (luminance),  $\Delta C$  (saturation),  $\Delta H$  (hue).



color bar for visualization of color differences:  
from dark green ( $\Delta E = 0$ ) to dark red ( $\Delta E = \text{maximum value defined in the specification}$ )

## RESOLUTION



Resolution is measured on the nine resolution patches (slanted edges):

TL - top left	TC - top center	TR - top right
CL - center left	CC - center center	CR - center right
BL - bottom left	BC - bottom center	BR - bottom right

The thin black horizontal lines illustrates the specification limits. The bars are colored green or red depending on whether the results are within (green) or outside (red) the tolerance.

**Max Modulation:** The maximum Modulation is 1 for an unsharpened image. If sharpening is applied in the image processing the modulation may rise. It shall not be higher than the value set in the specifications.

**Color MisRegistration:** The diagram represents the shift of color channels to each other.

**Sampling Efficiency:** Sampling efficiency displayed horizontal vs. vertical. If the limiting frequency (at 10% modulation) equals Nyquist frequency, sampling

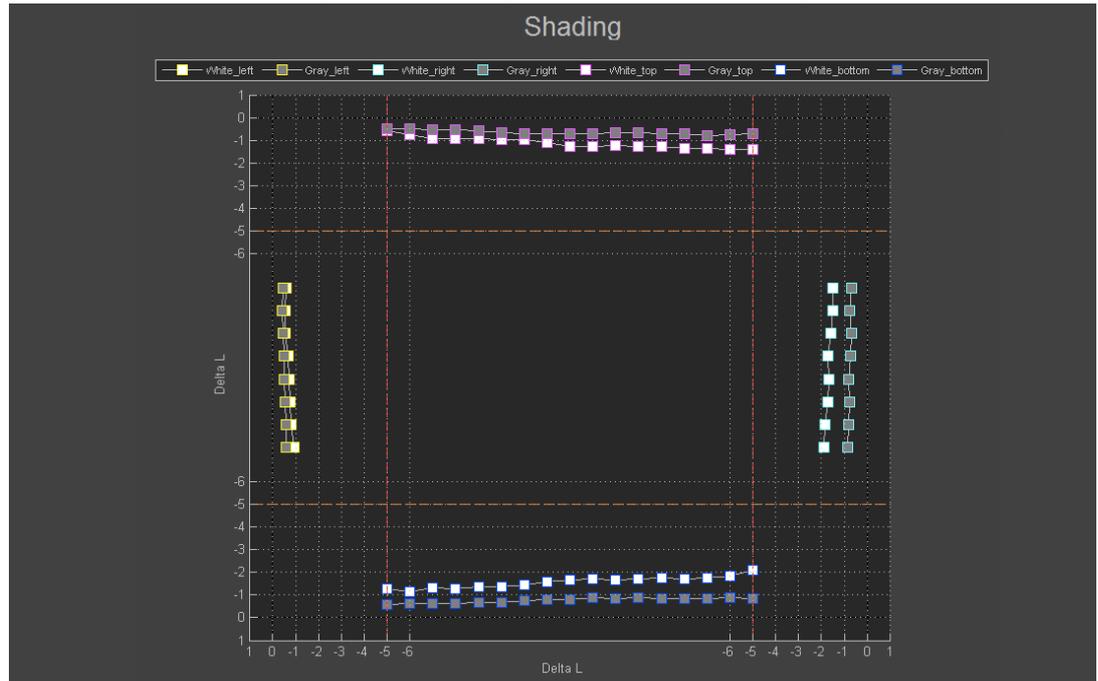


	efficiency ist 100%. The absolute comparison is shown in the lower center diagram.
<i>MTF 10:</i>	MTF 10 is the highest spatial frequency with with a modulation greater or equal 0.1 (10%).
<i>MTF 50:</i>	MTF 50 is the highest spatial frequency with a modulation greater than 50%.
<i>Sampling Efficiency:</i>	If the limiting frequency (at 10% modulation) equals Nyquist frequency, sampling efficiency ist 100%. The absolute comparison is shown in the lower center diagram.
<i>Claimed Sampling Rate:</i>	The sampling rate is specified in the meta information of the file. Most likely the sampling rate is set in the control software (ppi and the related lp/mm). If it can not be obtained the default setting will be used instead. It can be changed in the settings tab.
<i>Obtained Sampling Rate:</i>	The sampling rate measured on the image (using the average distance of the black lines in the background).
<i>Resolved Elements:</i>	The obtained sampling rate x sampling efficiency (usable sampling rate).

## SHADING

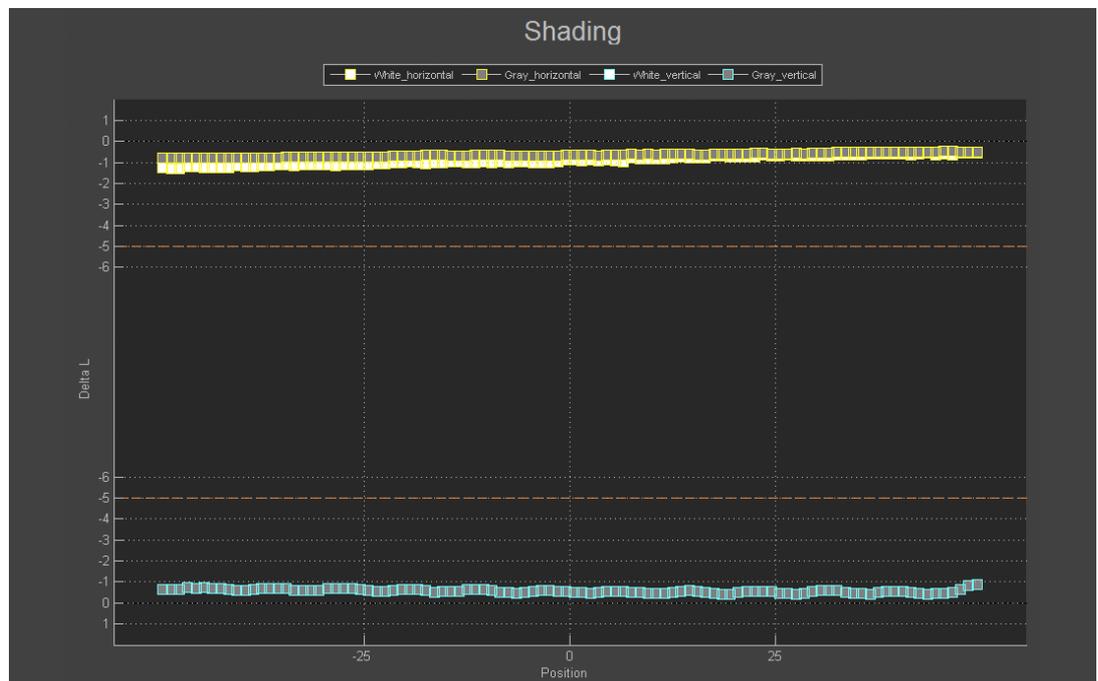
Shading describes the lost of intensity. Using the dropdown menu you can switch between representation „*grid*“ and „*lines*“.

*Grid:* The shading measurement is done inside the green marked rectangle displayed in the *Image View*. The  $\Delta L$  values are shown for the right, left, upper and lower border of the rectangle respectively for the white and gray patches. Each measuring point is one white respectively one gray patch within the rectangle.



Shading grid

*Lines:* The shading measurement is done on the white and gray lines at the upper (horizontal) and left (vertical) border. 50 measuring points uniformly distributed over the lines.

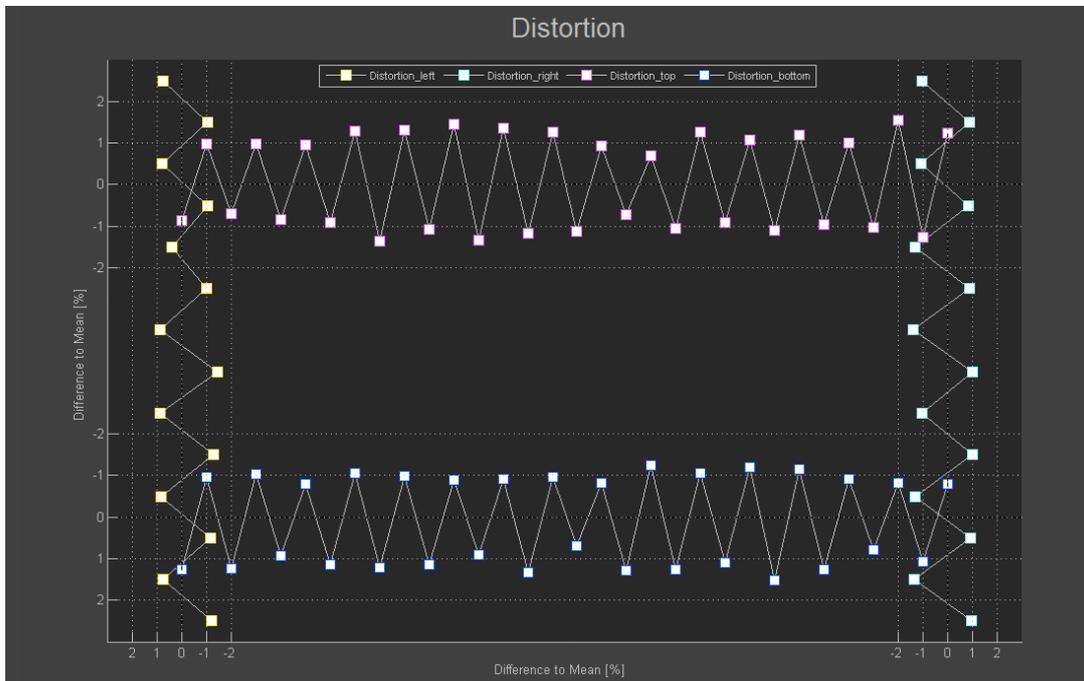


Shading lines

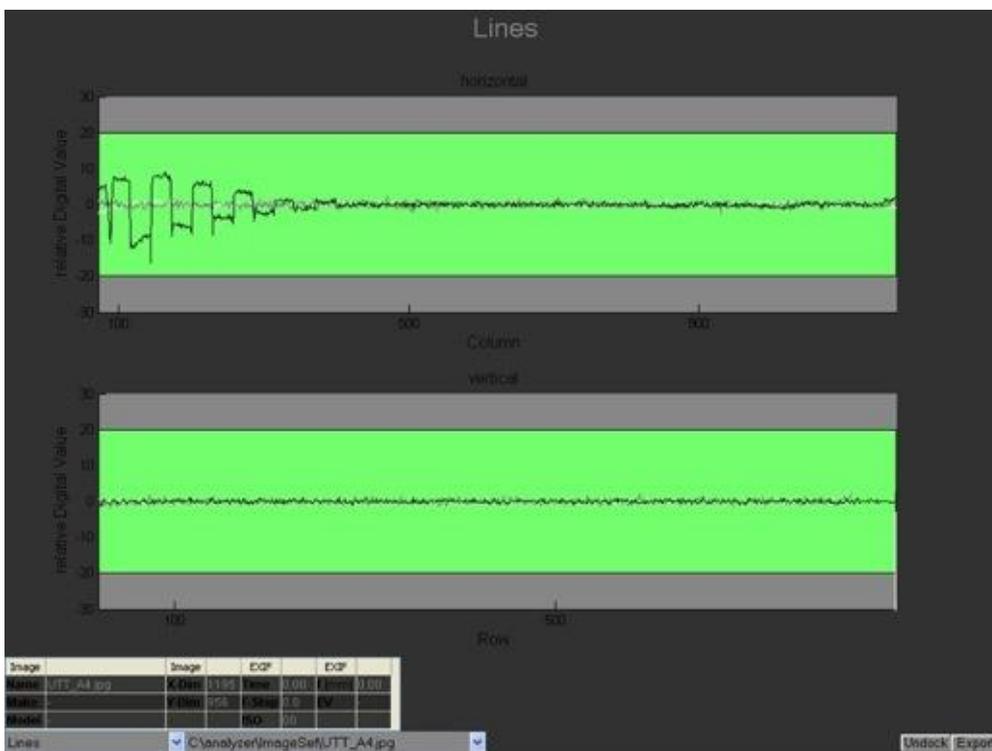


## DISTORTION

The distortion measurement is done inside the green marked rectangle displayed in the *Image View*. The width of the squares are compared to the average width over the whole image. The results of the distortion measurement are expressed as percentage.



## Lines





The white, black and gray lines at the upper (horizontal) and left (vertical) boarder are checked if lines are outside the expected values. So e.g. stripe patterns can be identified.

Before calculation, the lines are corrected for shading. The average for black, gray and white is build and the corresponding positive/negative deviation is calculated and displayed in the graph.



## 9 COPYRIGHT AND TRADEMARKS

### TRADEMARKS

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iQ-Analyzer is distributed with an automated FFmpeg 32-bit Windows build made by Ramiro Polla.

FFmpeg is licensed under GNU LGPL (<http://www.gnu.org/licenses/lgpl.txt>) and GNU GPL

(<http://www.gnu.org/licenses/gpl.txt>) licenses. FFmpeg is linked with libX264 (GPL).

You can download the complete source code used to build FFmpeg here:

<http://ffmpeg.arrozcru.org/autobuilds/>

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VLC (Copyright © 1996-2020 by the VideoLAN-Team): <http://www.videolan.org/vlc/>

iQ-Analyzer is distributed with a Windows installer of VLC Player. Please make sure the ActiveX plugin is installed in order to use the Video Module with video files.

VLC media player is licensed under GNU GPL (<http://www.gnu.org/licenses/gpl.txt>)

You can download the complete source code here: <http://www.videolan.org/vlc/download-sources.html>

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ExifTool (Copyright © 2003-2020 by Phil Harvey): <http://www.sno.phy.queensu.ca/~phil/exiftool/>

iQ-Analyzer is distributed with the stand-alone Windows executable of ExifTool. This is free software.

To install ExifTool on Mac OS X please follow the instructions on the ExifTool homepage.

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dcrw (Copyright © 1997-2020 by Dave Coffin): <http://www.cybercom.net/~dcoffin/dcrw/>

iQ-Analyzer is distributed with custom builds of dcrw for Windows and Mac OS X. This is free software.

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